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No. 2,296.] *FRIDAY, NOVEMBER 20, 1896.* *[Vol. XLV.*

ONE-HUNDRED-AND-FORTY-THIRD SESSION, 1896-97.

COUNCIL.

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J. O. Chadwick and Co.

SESSIONAL ARRANGEMENTS.

The Opening Meeting of the One-Hundred-and-Forty-Third Session was held on Wednesday evening, the 18th of November, at Eight p.m., when the opening address was delivered by Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E , Chairman of the Council. The subject of the address was "The Arts, Manufactures, and Commerce of India."

The following arrangements have been made for the four meetings before Christmas :—

November 25.—W. Worby Beaumont, M.Inst.C.E., "Recent Developments in Mechanical Road Carriages." Sir Frederick Bramwell, Bart., D.C.L., F.R.S., will preside.
December 2.—W. A. S. Hewins, M.A., "The Teaching of Economics." Sir Owen Roberts, M.A., will preside.
,, 9.—Bennett H. Brough, Assoc.R.S.M., "Mining at Great Depths." Professor H. Bauerman, F.G.S., will preside.
,, 16.—Arnold Dolmetsch, "The Chamber Music of Purcell, Handel, and Bach." (With Illustrations on the orignial Instruments for which it was written.)

For subsequent meetings the following papers have been promised :—

R. Brudenell Carter, F.R.C.S., "Children's Sight."
Everard R. Calthorpe, "Light Railways."
George Lacy Hillier, "Cycling—Historical and Practical"
George Clulow, "A Half Century of Line Engraving, 1780-1830."
Leo McCulloch, "Lithography as a Mode of Artistic Expression."
W. H. St. John Hope, M.A., "The Artistic Treatment of Heraldry."
M. J. R. Dunstan, M.A., F.R.S.E., "Dairy Produce and Milk Supply."
W. B. Esson, M.Inst.C.E., "The Transmission of Power by Alternating Electric Currents."
Percy F. Frankland, Ph.D., F.R.S., "London Water Supply."
David Crole, "The Chemistry of Tea."
Moreton Frewen, "The Evolution of the Silver Question."
William Lee-Warner, M.A., I.C.S., "The Moral Advance of the Peoples of India during the Reign of Queen Victoria."
Michael Francis O'Dwyer, "A Visit to Russian Central Asia."
Thomas Barraclough, "Cultivation and Manufacture of Rhea Fibre."

INDIAN SECTION.

Thursday Afternoons, at Half-past Four o'clock:—

January 21, February 11, March 11, April 1, 29, May 20.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

January 19, February 16, March 16, April 6, May 4, 25.

Arrangements are being made for a series of papers to be given in this Section descriptive of the progress of the British Colonies during the past sixty years of Her Majesty's reign. The first meeting will be held on Tuesday, January 19th, when an Introductory Address will be delivered by the Right Hon. Sir CHARLES DILKE, Bart., M.P.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock:—

January 26, February 9, March 2, 30, April 27, May 11.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

PROF. VIVIAN B. LEWES, "The Use of Gas for Domestic Lighting." Three Lectures.

LECTURE I.—NOVEMBER 23.—The principles of illumination and the measurement of light—Illuminating value and illuminating effect—Domestic lighting—Flat flame, Argand, and regenerative burners.

LECTURE II.—NOVEMBER 30.—Incandescent mantles and burners—The effect of globes in diffusing and absorbing light—Street lighting—Atmospheric influences and the penetration of light.

LECTURE III.—DECEMBER 7.—Gaseous illumination where coal-gas is not available—Oil-gas and its properties—Acetylene, its manufacture and use—Acetylene burners and generators—Railway and tramcar lighting.

WILLIAM BURTON, F.C.S., "Material and Design in Pottery." Four Lectures.
January 18, 25, February 1, 8.

C. F. CROSS, F.C.S., "The Industrial Uses of Cellulose." Three Lectures.
February 15, 22, March 1.

PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., "Alloys." Four Lectures.
March 15, 22, 29, April 5.

LEWIS FOREMAN DAY, "Design in Lettering." Four Lectures.
May 3, 10, 17, 24.

HOWARD LECTURES.

Thursday Evenings, at Eight o'clock:—

PROF. JAMES A. EWING, M.A., F.R.S., "The Mechanical Production of Cold." Six Lectures. January 28, February 4, 11, 18, 25, March 4.

JUVENILE LECTURES.

Two Lectures, suitable for a Juvenile audience, will be delivered on Wednesday evenings, the 6th and 13th of January, at Seven p.m., by CLINTON T. DENT, F.R.C.S., Past-President of the Alpine Club, on "The Growth and Demolition of Mountains."

CONVERSAZIONE.

The Annual Conversazione of the Society is provisionally fixed for Wednesday, June 23. Each member will receive a card for himself, and one for a lady.

PROCEEDINGS OF THE SOCIETY.

CHARTER.—THE SOCIETY OF ARTS was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom; and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country."

THE SESSION.—The Session commences in November, and ends in June. The number of Meetings held during the Session amounts to between 70 and 80.

ORDINARY MEETINGS.—At the Wednesday Evening Meetings during the Session, papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session, three of which during the Session 1896-7 will be at the Imperial Institute.

FOREIGN AND COLONIAL SECTION.—This Section was formed in 1874, under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies, and with Foreign Countries. Six or more Meetings are held during the Session.

APPLIED ART SECTION.—This Section was formed in 1886, for the discussion of subjects connected with the industrial applications of the Fine Arts. Six or more meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are several Courses every Session, and each course consists generally of two or more Lectures.

ADDITIONAL LECTURES.—Special Courses of Lectures are occasionally given.

JUVENILE LECTURES.—A Short Course of Lectures, suited for a Juvenile audience, is delivered to the Children of Members during the Christmas Holidays.

ADMISSION TO MEETINGS.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted on signing their names. Every member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures Special tickets are issued.

JOURNAL OF THE SOCIETY OF ARTS.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

EXAMINATIONS.—Examinations, founded in 1853, are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal divisions of a Commercial Education, Domestic Economy, and Music. A Programme, containing detailed information about the Examinations, can be had on application to the Secretary.

LIBRARY AND READING-ROOM.—The Library and Reading-room are open to Members, who are also entitled to borrow books.

CONVERSAZIONI are held, to which Members are invited, each Member receiving a card for himself and a lady.

MEMBERSHIP.

The Society numbers at present between three and four thousand Members. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day preceding election; or a Life Subscription of Twenty Guineas may be paid.

Every Member whose subscription is not in arrear is entitled:—

To be present at the Evening Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.

To be present and vote at all General Meetings of the Society.

To be present at the Cantor and other Lectures, and to introduce one visitor.

To have personal free admission to all Exhibitions held by the Society at its house in the Adelphi.

To be present at all the Society's *Conversazioni*.

To receive a copy of the Weekly *Journal* published by the Society.

To the use of the Library and Reading-room.

Candidates for Membership are proposed by three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council.

All subscriptions should be paid to the Secretary, Sir Henry Trueman Wood, and all Cheques or Post-office Orders should be crossed "Coutts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C.

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1896-97. It is issued subject to any necessary alterations:—

NOVEMBER, 1896.

1	**S**	
2	M	
3	Tu	
4	W	
5	Th	
6	F	
7	S	
8	**S**	
9	M	
10	Tu	
11	W	
12	Th	
13	F	
14	S	
15	**S**	
16	M	
17	Tu	
18	W	Ordinary Meeting
19	Th	(Opening Meeting of the Session)
20	F	
21	S	
22	**S**	
23	M	Cantor Lecture I. 1
24	Tu	
25	W	Ordinary Meeting
26	Th	
27	F	
28	S	
29	**S**	
30	M	Cantor Lecture I. 2

DECEMBER, 1896.

1	Tu	
2	W	Ordinary Meeting
3	Th	
4	F	
5	S	
6	**S**	
7	M	Cantor Lecture I. 3
8	Tu	
9	W	Ordinary Meeting
10	Th	
11	F	
12	S	
13	**S**	
14	M	
15	Tu	
16	W	Ordinary Meeting
17	Th	
18	F	
19	S	
20	**S**	
21	M	
22	Tu	
23	W	
24	Th	
25	F	CHRISTMAS DAY
26	S	*Bank Holiday*
27	**S**	
28	M	
29	Tu	
30	W	
31	Th	

JANUARY, 1897.

1	F	
2	S	
3	**S**	
4	M	
5	Tu	
6	W	Juvenile Lecture I.
7	Th	
8	F	
9	S	
10	**S**	
11	M	
12	Tu	
13	W	Juvenile Lecture II.
14	Th	
15	F	
16	S	
17	**S**	
18	M	Cantor Lecture II. 1
19	Tu	For. & Col. Section
20	W	Ordinary Meeting
21	Th	Indian Section
22	F	
23	S	
24	**S**	
25	M	Cantor Lecture II. 2
26	Tu	Applied Art Section
27	W	Ordinary Meeting
28	Th	Howard Lecture 1
29	F	
30	S	
31	**S**	

FEBRUARY, 1897.

1	M	Cantor Lecture II. 3
2	Tu	
3	W	Ordinary Meeting
4	Th	Howard Lecture 2
5	F	
6	S	
7	**S**	
8	M	Cantor Lecture II. 4
9	Tu	Applied Art Sectior
10	W	Ordinary Meeting
11	Th	Howard Lecture 3 Indian Section
12	F	
13	S	
14	**S**	
15	M	Cantor Lecture III. 1
16	Tu	For. & Col. Section
17	W	Ordinary Meeting
18	Th	Howard Lecture 4
19	F	
20	S	
21	**S**	
22	M	Cantor Lecture III. 2
23	Tu	
24	W	Ordinary Meeting
25	Th	Howard Lecture 5
26	F	
27	S	
28	**S**	

MARCH, 1897.

1	M	Cantor Lecture III. 3
2	Tu	Applied Art Section
3	W	Ordinary Meeting
4	Th	Howard Lecture 6.
5	F	
6	S	
7	**S**	
8	M	
9	Tu	
10	W	Ordinary Meeting
11	Th	Indian Section
12	F	
13	S	
14	**S**	
15	M	Cantor Lecture IV. 1
16	Tu	For. & Col. Section
17	W	Ordinary Meeting
18	Th	
19	F	
20	S	
21	**S**	
22	M	Cantor Lecture IV. 2
23	Tu	
24	W	Ordinary Meeting
25	Th	
26	F	
27	S	
28	**S**	
29	M	Cantor Lecture IV. 3
30	Tu	Applied Art Section
31	W	Ordinary Meeting

APRIL, 1897.

1	Th	Indian Section
2	F	
3	S	
4	**S**	
5	M	Cantor Lecture VI. 4
6	Tu	For. & Col. Section
7	W	Ordinary Meeting
8	Th	
9	F	
10	S	
11	**S**	
12	M	
13	Tu	
14	W	
15	Th	
16	F	GOOD FRIDAY
17	S	
18	**S**	EASTER SUNDAY
19	M	*Bank Holiday*
20	Tu	
21	W	
22	Th	
23	F	
24	S	
25	**S**	
26	M	
27	Tu	Applied Art Section
28	W	Ordinary Meeting
29	Th	Indian Section
30	F	

MAY, 1897.

1	S	
2	**S**	
3	M	Cantor Lecture V. 1
4	Tu	For. & Col. Section
5	W	Ordinary Meeting
6	Th	
7	F	
8	S	
9	**S**	
10	M	Cantor Lecture V. 2
11	Tu	Applied Art Section
12	W	Ordinary Meeting
13	Th	
14	F	
15	S	
16	**S**	
17	M	Cantor Lecture V. 3
18	Tu	
19	W	Ordinary Meeting
20	Th	Indian Section
21	F	
22	S	
23	**S**	
24	M	Cantor Lecture V. 4
25	Tu	For. & Col. Section
26	W	Ordinary Meeting
27	Th	
28	F	
29	S	
30	S	
31	M	

JUNE, 1897.

1	Tu	
2	W	
3	Th	
4	F	
5	S	
6	**S**	WHIT SUNDAY
7	M	*Bank Holiday*
8	Tu	
9	W	
10	Th	
11	F	
12	S	
13	**S**	
14	M	
15	Tu	
16	W	
17	Th	
18	F	
19	S	
20	**S**	
21	M	
22	Tu	
23	W	Conversazione
24	Th	
25	F	
26	S	
27	**S**	
28	M	
29	Tu	
30	W	Annual General Meeting

The chair will be taken at Eight o'clock at each of the Ordinary Meetings, the Cantor Lectures, and the Meetings of the Applied Art Section.

The Meetings of the Indian Section will commence at Half-past Four, and the Foreign and Colonial Section at either Half-past Four or Eight o'clock, as may be announced from time to time.

The Annual General Meeting will be held at Four o'clock.

The Juvenile Lectures will be given at Seven o'clock.

Notices.

APPLIED ART SECTION.

A meeting of the Committee of the Applied Art Section was held on Tuesday, 17th inst., at 4 p.m. Present:—Sir George Birdwood, K.C.I.E., C.S.I., in the chair; Sir Owen Tudor Burne, K.C.S.I., C.I.E., Professor A. H. Church, F.R.S., Lewis F. Day, I. Hunter Donaldson, W. Gowland, Sir Charles M. Kennedy, K.C.M.G., C.B., Alderman Sir Stuart Knill, Bart., Vincent J. Robinson, C.I.E , Phené Spiers, Hugh Stannus, H. Buxton Morrish, Thomas Wardle, with Sir Henry Trueman Wood, Secretary of the Society, and Henry B. Wheatley, Secretary of the Section.

EXAMINATIONS, 1897.

The dates fixed for the Society's Examinations in 1897 are Monday, March 22nd, Tuesday, 23rd, Wednesday, 24th, and Thursday, 25th.

Special attention is called to the fact that Elementary Examinations are now provided in French, German, and Spanish. A Syllabus for each of these subjects is included in the Programme.

Copies of the Programme, with full details, and an Appendix containing last year's questions and reports by the Examiners, can be had, price 3d., post-free, on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, London, W.C.

Proceedings of the Society.

FIRST ORDINARY MEETING.

Wednesday, November 18, 1896; Major-Gen. Sir OWEN TUDOR BURNE, K.C.S.I., C.I.E., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Ackland, Charles George Heber, Catteral-house, Chestnut-avenue, Hampton.
Aris, John Whitton, B.A., Sherriff-house, 24, Sherriff-road, West Hampstead, N.W.
Aston, William Henry, 46, Eagle Wharf-road, New North-road, N.
Baden-Powell, Captain B. F. S., 8, St. George's-place, S.W.
Banerjee, Hon. Gooroo Dass, Narikeldanga, Calcutta.
Barrett, S., Moyeni, Quthing, Basutoland, South Africa.
Baxendale, A. S., Selangor, Straits Settlements.
Blackshaw, Walter, 65, Thornhill-road, Croydon.
Borgström, Henrik Emil Herbert, Helsingfors, Finland.
Bradberry, Charles Frederick, Battersea Works, S.W.
Bradford, Milton, 35, Queen Victoria-street, E.C., and 2, Old Park - avenue, Nightingale - lane, Clapham-common, S.W.
Brough, Bennett Hooper, 31, St. Leonard's-terrace, Chelsea, S.W.
Burkinshaw, William Parker, The West-hill, Hessle, near Hull.
Burt, George, 37, Grosvenor-road, S.W.
Cairncross, Thomas Wilson, Abbey Craig, Woodside-road, Cape Town, Cape Colony.
Chisholm, Robert F., Neuenheim, Heidelberg, Germany.
Collier, George, Dingle, Ireland.
Cookson, Alfred Chorley, 108, Manor-road, Brockley, Kent.
Cutting, Charles Henry, Parliament Works, Parliament-street, Derby.
Davies, James Mair, 166, St. Vincent - street, Glasgow, and 46, Queen Victoria-street, E.C.
Davidson, Charles Irvine, St. Gothard, Princes-road, Lewisham, S.E.
Dronsfield, Joseph Standring, Alexandra - park, Oldham.
Edye, Lieut.-Colonel Lourenco, Admiralty, Whitehall, S.W.
Field, James Hermann, Messrs. Taylor and Field, 14, Victoria - street, S.W., and Claremont, Woodberry-down, N.
Frecheville, William, Claremont, Nutfield, Redhill, Surrey.
Frewen, Moreton, B.A., 25, Chesham-place, S.W.
Gilbertson, Francis William, B.A., Glyn Têg, Pontardawe, R.S.O., Glamorganshire.
Gosnell, C. A., 93, Upper Thames-street, E.C.
Grant, William Henry, Foleshill, Coventry.
Gray, William Wythers, 4, Bene't-street, Cambridge.
Grimes, Herbert Thomas Redman, 27, Chancery-lane, W.C.
Harrison, Thomas, 85, Blenheim-crescent, Notting-hill, W.
Hart, Herman, 1, Melina place, N.W.
Himbury, William Henry, Bonny, West Coast of Africa, and New Lyric Club, Coventry-street, W.
Honeysett, Arthur, 39, Victoria-street, S.W., and 189, The Grove, Hammersmith, W.
Hopkins, John, Little Boundes, near Tunbridge Wells, and 79, Mark-lane, E.C.
Humphery, George Richard, 16, St. Donatt's-road, New-cross, S.E.
Jackson, A. M. T., M.A., Bombay, India.
Jennings, Arthur Seymour, 298, Friern-road, Dulwich, S.E., and 83, St. Paul's-churchyard, E.C.
Johnson, Harry Croom, The Elms, Wrexham.
Joseph, Francis Edward, Double Bay, Sydney, and Equitable-building, Sydney, New South Wales.

Keeson, H. V. Cuthbert, 40, Loudoun-road, St. John's-wood, N.W.
Kelly, Mark Jamestown, 7 and 8, Idol-lane, E.C.
Laurie, James, Government Marine Surveyor's Office, Singapore.
Lawrance, Walter, 8, Delahay-street, S.W.
Leaver, Cyril D'Arcy, 14, Horbury-crescent, W.
Leggett, Lieut. Edward Humphrey Manisty, R.E., Royal Arsenal, Woolwich.
Lister, Hon. Martin, Negri Sembilan, Straits Settlements.
Macaulay, Herbert, Crown Lands Office, Lagos, West Africa.
Marshall, Frederic, Q.C., 3, Harcourt-buildings, Temple, E.C.
Martin, Sir Thomas Acquin, Silverlands, Eridge, Sussex.
Meagher, J.J., J.P., St. Lucia, West Indies.
Millar, William Galt, 1, Arcade-chambers, Reading, Berkshire.
Mitchell, George Sharman, Upper Adhurst, Petersfield, Hants.
Mogren, Adolph, 164, Edmund-street, Birmingham.
Olubi, Jonathan C., Breadfruit-street, Lagos, West Africa.
Oswald, Herm E., Belize, British Honduras.
Oxley, Erneste, Melbourne-lodge, Clay Cross, Derbyshire.
Pfister, Frederick, 15, Fore-street, E.C.
Plunkett, Count George Noble, 26, Upper Fitzwilliam-street, Dublin.
Popple, John, Groves-hall, Sleights, near Whitby, and 47, Flowergate, Whitby.
Reid, James, Leadenhall-house, 101, Leadenhall street, E.C.
Reid, John R., 62, Park-road, Haverstock-hill, N.W.
Rochford, Joseph, Turnford, near Broxbourne.
Sansom, Alfred Edward, 198, Uttoxeter Old-road, Derby.
Scott, Prof. Robert Julian, Canterbury-college, Christchurch, New Zealand.
Shaw, James Stenhouse, 87, Newgate-street, E.C.
Simonds, George, The Priory, North-bank, St. John's Wood, N.W.
Spink, Henry, 36, Goldstone-villas, West Brighton.
Stewart, Captain James, D.L., Alltyrodyn, Llandyssil, South Wales.
Sugg, John Walter, Knollbrow, Dorking, Surrey.
Sutton, Arthur Warwick, Bucklebury-place, Woolhampton, Berks.
Thomson, Surgeon-Major General William Arthur, care of Sir C. R. McGrigor, Bart., and Co., 23, Charles-street, St. James's-square, S.W.
Valentine, Charles Richard, Whitcliffe, Grove-park, S.E.
Weir, William Park, Aviemore Railway Works, Carr-bridge, Inverness-shire.
Welton, William Smart, 73, The Chase, Clapham-common, S.W.
West, Frank Adamson, 22, Sheppard-street, New Swindon, Wilts.
While, Alfred Mounier, 42, Westbourne-road, Sheffield.
Wingate, Hamilton M., care of James Wingate and Co., 4, North-court, Royal Exchange, Glasgow.
Withers, Samuel, care of The Brayton Petroleum Motor Company, Hythe-road, Willesden Junction, N.W.

AND AS HONORARY CORRESPONDING MEMBERS:—

Agassiz, Alexander, For.Memb.R.S., Cambridge, Mass.
Berthelot, Professor Marcellin, For.Memb.R.S., Grand Officer Legion of Honour, Perpetual Sec. Acad. des Sciences, Paris.
Brandis, Sir Dietrich, K.C.B., Ph.D., F.R.S., Bonn.
Bunsen, Professor Robert Wilhelm, Ph.D., For. Memb.R.S., Professor of Chemistry, University of Heidelberg.
Cannizzaro, Professor Stanislao, For. Memb.R.S., Senator, University of Rome.
Cleve, Professor P. T., Ph.D., University of Upsala.
Ferrari, Professor Galileo, Turin.
Fresenius, C. Remigius, Ph.D., Wiesbaden.
Giglioli, Professor Italo, Naples.
Langley, Professor Samuel Pierpoint, LL.D., Secretary, Smithsonian Institution, Washington, D.C.
Lindström, Johann Edward, Stockholm.
Mascart, Eleuthère Elie Nicolas, For.Memb.R.S., Memb. Inst. de France, Bureau Central Météorologique, Paris.
Mendeleef, Professor Dmitri Ivanovitch, For.Memb. R.S., LL.D., Ph.D., St. Petersburg.
Schneider, Henri, Creusot, France.
Sellers, William, M.Inst.C.E., Philadelphia.
Steinheil, Dr. Adolphe, Principal of the Optical Institute, Munich.
Vambéry, Professor Arminius, Budapest.

The Chairman delivered the following Address:—

INDIA: ITS ARTS, MANUFACTURES, AND COMMERCE.

As the Council of your Society have been good enough to elect me as their Chairman for the forthcoming Session, it becomes my duty to deliver the opening address of this evening, a duty which I am emboldened to undertake through a full appreciation of the patience and courtesy with which you have listened to those who have preceded me in the discharge of similar functions.

After giving the matter some consideration, I have come to the conclusion that a few words on the Arts, Manufactures, and Commerce of India might not be unacceptable to a Society which has taken so valued an interest of late years in questions connected with that country. But I am, of course, conscious that I can say very little on the subject that is not already known to you, and that I labour under the disadvantage of an experience which has had more to do with military and political questions than with those relating to arts, manufactures, and commerce. I will, however, do my best to remind you of certain well-known facts connected with these matters, for the encouragement of which the Society of Arts was founded nearly a century and a-half ago; a work which it still pursues with unabated energy under its distinguished President, His Royal Highness the Prince of Wales.

As you are all aware, India was in ancient times regarded as a country that abounded in choice productions both of nature and of art. Although then only imperfectly known to the nations of the west, an extensive commerce with it was maintained up to the Middle Ages through the ports of Egypt and the Red Sea; while, after the discovery of the Cape of Good Hope, many of the great maritime States contended with fleets and armies for its possession. In later times, England and France became the chief competitors for this region of wealth and romance, and the factories they then established became afterwards military posts of great value. A prolonged contest resulted, as you know, in the loss by France of her momentary predominance, and in the rise of her then great rival, England, to the position which now enables her to control India from the Himalayan mountains to Cape Comorin, and from Afghanistan and Baluchistan to the frontiers of Burmah.

On the north, India is separated from the elevated table-land of Thibet by the precipitous wall of the Himalayas, the highest land of the Asiatic continent. On the west, the Suleiman mountains divide it from Afghanistan and Baluchistan; on the east, ranges of well-defined hills and valleys cut it off from China and Siam; while on the south is the sea. The extensive region situated within these limits comprises about 1,800,000 of square miles of land, with a population, according to the last census, of 288,000,000 of people, who speak about eighty different languages. Of these, some 148,000,000 are males, and 140,000,000 are females, among the latter of whom are about 22,000,000 unfortunate widows. This vast population (which is considerably more than double that of the Roman Empire at its greatest extension, and nearly eight times greater than that of the United Kingdom) is mainly agricultural; that is to say, that while about 180,000,000 are employed in agricultural pursuits, only about 30,000,000 are traders and manufacturers, the remainder being employed in various minor capacities, 140,000 only being said to spend their time in sport and amusement! If we separate this great population into nationalities or religions, we find that there are:—

Hindus................	207,731,727
Mahomedans	57,321,164
Aboriginals............	9,280,467
Buddhists	7,131,361
Christians	2,284.380
Sikhs	1,907,833
Jains	1,416,638
Parsees	89,904
Jews..................	17,194
Others................	42,763
Total (1891) ..	287,223,431

Avoiding any attempt to describe the various characteristics of these interesting races, I may remind you of a fact which has often been mentioned in past years by myself and others, viz., that Our Most Gracious Sovereign rules directly over more than double the number of Mahomedans that are directly or indirectly under the Sultan of Turkey. The British nation has therefore a very substantial interest, be it in Europe or in Asia, in every question affecting these great and noble people.

The natural features of India are of an extremely diversified character, the country comprehending within its bounds every variety of climate, soil, and scenery. Thus we have Northern India, with its impregnable rampart of the Himalayas, or "dwelling place of snow"; India proper, or the fertile plains of the great rivers issuing from the base of these mountains; the Deccan, which consists for the most part of a high table-land; and the eastern and western seabords, which are known as the coasts, respectively, of Coromandel and Malabar.

The Alpine, or Himalayan, region of India, which forms its northern barrier, is a narrow strip of land about 130 miles in breadth. Here are icy deserts; there stupendous peaks, some of which are six miles in height; mountains of which the southern slopes, contrary to our own ideas of what is correct, are precipitous and bare, while those exposed to the north are covered with rich forests and vegetation.

After the intervention of a dark belt of jungle some 20 miles in breadth, called the Terai, we come to the plains watered by the Himalayan rivers, comprising such important provinces as Bengal, Assam, the North-West Provinces, Oudh, the Punjaub, Sind, and Rajpootana;

regions which, as a whole, contain about 180,000,000 of the population. Here the cold and bracing air of the upper country is exchanged for burning heat; and in some parts sandy deserts form a considerable portion of the soil. Great rivers, however, traverse this region in their onward career to the sea; such as the Indus, which runs a course of over 1,800 miles; the Sutlej, of 900 miles; the Brahmaputra, of 1,700 miles; the Ganges, the pre-eminently sacred river of India, which flows through 1,600 miles of thickly-populated land, and other rivers of a lesser size which need not here be named.

The third division of the peninsula, known as the Deccan, or the "South," (literally, "the right-hand" land), comprises the Central Provinces, Berar, Madras, Bombay, Mysore, and some of the leading native states of Central India, with a population of about 50,000,000; while its seabord is a series of flat-topped and peaked basaltic mountains and profound valleys, covered with forests that produce pepper, cassia, frankincense, and many aromatic gums.

To give a rough idea of the size of India, although it is not by any means the largest possession of the British Crown, I may remind you that the single governorship of Bengal is almost as large as France; that Madras exceeds Great Britain and Ireland; that Bombay equals Germany; that the North West Provinces and Oudh cover as much space as Great Britain, Belgium, and Holland; that the size of the Punjaub is equal to Italy; that Burmah is as extensive as Spain; and that the separate native States put together, have, in addition, an area equal to that of the United Kingdom, Germany, and France, combined.

These great tracts of country contain a population as varied in character and thought as the Norwegian and the Italian; and, similarly, the climate has its extremes of heat and cold, and of drought and rain. Indeed, the Himalayas, as we are reminded by that able writer, Sir William Hunter, play a great part in the well-being of this interesting land; for they stand as a rampart around the northern frontier of India, and collect and store up water for the tropical plains below. Thus, throughout the summer, vast quantities of water are exhaled from the Indian Ocean; this moisture gathers into vapour, and is borne northwards by the monsoon,* or regular wind, which sets in from the south in the month of June; and the monsoon carries these masses of cloud across India, forming the "rainy season," on which agriculture so entirely depends. Yet a large quantity of the moisture does not fall as rain in passing over the hot plains, but is eventually dashed against the Himalayas, where it either descends in showers on their outer slopes, or is frozen to snow in its attempt to cross their inner heights.

As an interesting fact in meteorology, it may be remarked that, at Cherra Poonjee, in Assam, where the monsoon first strikes the hills in that quarter, some 523 inches of rain fall annually; and in one year (1861) as many as 805 inches were reported, of which 366 inches fell in the single month of July! While, therefore, the yearly rainfall in London is about two feet, and that of the plains of India from one to six feet, the rainfall at Cherra Poonjee is from 30 to 40 feet; and, indeed, in one year, 67 feet of water fell from that sky, or sufficient to cover a three-storied house! Notwithstanding this apparently great water supply, however, India is subject, alas, to a recurrence of famine from failure of the regular rainfall. The first of these of which we have any trustworthy record occurred in 1769, and it was followed by eleven others in recurrent periods, till that of 1876-77, in Southern India, which famine alone cost Indian revenues about £11,000,000 sterling, not including the indirect cost in loss of revenue. I myself witnessed sad scenes in Madras when making a special visit to that Presidency with the Viceroy (the late Earl of Lytton) during the height of this last period of distress; and I learnt to realise for the first time what a terrible enemy is famine to the country which it devastates, and to the poor suffering and patient population which it mows down with the dreadful scythe of starvation and death!

The object of this address does not admit of my taking up your time by describing the system of government, or the position of the native States, or the many other important matters connected with a dominion which has risen, so far as we are concerned, from a few factories established in Southern India about 300 years ago, to the great Empire which now exists. And indeed what I have already said has been set forth with the sole object of pointing out the difficulties experienced by such men as Sir George Birdwood and others, who have had to deal with the arts, manufactures, and commerce of a country occupied by a congeries of nationalities as varied in their character and employments as those of Northern and Southern or of Eastern and Western Europe, and with climatic and racial difficulties which do their best to obstruct all national progress. I may say briefly, however, that this Empire is governed by a Viceroy who is responsible to her Majesty's Government in this country; that it is protected by a military force which numbers about 73,000 European and 146,000 native troops, besides 30,000 volunteers; that it is irrigated by nearly 41,000 miles of canals, traversed by nearly 20,000 miles of railways, none of which may be said to have existed half-a-century ago; and covered with a network of about 46,000 miles of telegraph line.

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* The burst of the monsoon is graphically described, and philosophically explained, in the *Times* of 8th January, 1880.

As to its natural features and products, it may be mentioned that the mountainous tracts of the Himalayas produce all the plants and species of European grain, fruits, and flowers. Here are noble forests fruits, such as apricots, peaches, grapes, apples, pears, currants, raspberries, blackberries, and strawberries; roots, such as turnips, carrots, garlic, onions; and flowers and plants, such as roses, lilies of the valley, jasmine, buttercups, cowslips, sweet briar, and other fragrant blossoms. At the height of 6,000 feet appear the oak and the pine; at that of 3,000 feet, bamboos and rattans grow of enormous dimensions; while in some parts the pineapple, the orange, and the sugar-cane, and in others barley, millet, rice, and cotton flourish. The pastoral tribes feed considerable flocks on the lower hills and valleys; flocks which in summer climb the alpine country, and browse on the herbage adjacent to the region of perpetual frost and snow.

The vegetable produce of the plains in India is the same as in all tropical countries. Rice is the great staple of agriculture. Opium is the peculiar product of the province of Behar; it is also extensively cultivated in Malwa, and in other parts of India. Wheat is grown over 26,000,000 of acres. The cotton plant is also an important product of India, and is indigenous from Ceylon in the south to the Himalayas in the north. Indigo, tobacco, pepper, the areca nut, and betel leaf (invariably chewed by the natives) thrive in the low grounds where water is abundant; and the universal and vast consumption of vegetable oils in India for food or unguents, and for the lamp, is supplied by the extensive cultivation of mustard seed, linseed, and the cocoa nut. There is, also, an output of coal, amounting to about 3,000,000 tons annually (affording employment to 44,000 persons) besides a certain quantity of iron ore, earth oil, and gold; the latter in Mysore alone being worth, in 1895, Rx. 1,720,000, or about £1,000,000 sterling.

I may add that the present gross revenue of India is about Rx. 98,000,000, or £57,000,000 sterling; and with this introduction, which may help to remind you of the general features and conditions of this great country, will proproceed to the more direct consideration of the arts, manufactures, and commerce of India, although I do not propose to treat them in much detail.

As to Indian *art*; the word "art" is defined by Lord Bacon as a proper disposal of the things of nature by human thought and experience, so as to answer the several purposes of mankind, in which sense it stands opposite, so to speak, to nature. Art is principally used for a system of rules serving to facilitate the performance of certain actions, in which sense it has nothing in common with science—a system of speculative principles.

Coming, therefore, to "arts" as we understand them, they are, as you are aware, commonly divided into useful and mechanical, fine or liberal. The former are those wherein the hand and body are more concerned than the mind, and are known by the name of trades; the latter are such as depend more on the labour of the mind, and are the produce of imagination. In countries where the people are barbarous and illiterate, the progress of the arts is extremely slow. It seldom fails to be rapid when a people happen to be roused out of a torpid state by some fortunate change of national circumstances. The Athenians, for instance, made but a mean figure under the tyranny of Pisistratus, but upon regaining freedom and independence they were converted into heroes and artists; for art flourished with arms, and Athens became the chief theatre of science and fine arts.

In considering the subject of art, we must understand that constant application to a single operation confines and cramps the mind, and excludes all thought and invention. The artisan becomes dull, and his dullness affects the whole character and manners of the nation. Thus in a country where from want of hands several occupations must be carried on by the same person, the people are comparatively intelligent; whereas in a populous country where manufactures flourish, they are ignorant and unsociable. The same effect is visible in countries where an art or manufacture is confined to a certain class of men; and this effect is observed in India, where the people are divided into castes, which never mix even by marriage, and where every man follows his father's trade. Thus, the fine arts, which should always follow the useful arts, and which are generally confined to painting, sculpture, engraving, and architecture, do not find a leading space in the present occupations of modern India.

Among arts which the Hindus considered as supplementary parts of their divinely inspired knowledge were, we are told, those of medicine, war, music, and architecture. It is perhaps as well that painting was not included in this category, seeing that in pictorial art the people of India have never made much progress except perhap in miniature painting, and that their work, after all, in this branch of the fine arts, is not to be compared with that produced in European countries. Some of the book-cover illustrations, however, that have been executed in India, under Persian influence, are full of beauty, although they are mere copies, and are not original studies of Indian artists. It is to architecture that we chiefly look for the fine arts in India, and this is said to owe its development to Buddhist rather than to Hindu impulses. For the Buddhists were the great cave-builders of India, and their monasteries and shrines exhibit the history of architecture during many centuries, from the earliest caves and rock temples to the latest Jain structures famous for stucco and polychrome ornament.

The Græco-Bactrian kingdom profoundly influenced architecture and sculpture in Northern India; and the Mussulman conquerors brought in new forms and requirements of their own. Nevertheless Hindu art powerfully asserted itself in the Imperial work of the Moghuls and has left behind memorials (Hunter) which excite the admiration and astonishment of our age. The palace architecture of Gwalior, the mosques and mausoleums of Agra and Delhi, with several of the older temples of Southern India, stand unrivalled for grace of outline and elaborate wealth of ornament; and the beautiful Taj Mahal of Agra justifies Heber's exclamation that its builders had designed like Tritons and finished like jewellers! It must be said, moreover, that English decorative art in our day has borrowed largely from Indian forms and patterns; for the exquisite scrolls of the rock temples at Karli and Ajunta, the delicate marble tracery and flat wood carving of Western India, and the harmonious blending of forms and colours in the fabrics of Kashmir, have contributed to the restoration of taste in England; and Indian art work, when faithful to native designs, has obtained high praise in Europe.

Thus, in speaking of art, we must remember that in India the greater part of its industrial arts is hand-wrought, and is therefore more or less a work of art. On the other hand it is impossible, as Sir George Birdwood has reminded us, to rank the decorative arts of India in their crystallised condition, although perfect in form, with the ever living progressive arts of Europe, wherein the inventive and creative genius of the true poet, acting on his own spontaneous inspiration, asserts itself. The spirit of fine art is no doubt everywhere latent in India, but it has yet to be quickened into creative operation; and the Indian workman, from the humblest potter to the most cunning embroiderer, is a true artist, although he seldom rises above the tradition of his art. In short, the great characteristic of all art in India is the obvious absence from it of intellectual power. The hands do their work well, but there is a want of head. There is no science and no emulation, for each man follows the occupation of his father, and performs it in the same manner, like the revolution of one dull wheel, from generation to generation. Indeed, we are told on trustworthy authority, that it is doubtful whether during the last five centuries the native intellect of India has contrived a single tool or machine for the effecting of any useful or ornamental purpose.

As regards the *manufactures* of India; we all know that in every country of the world the nature and quality of the manufactures depend, in great measure, on the condition of the consumers. In past centuries in India, under native rule, these consisted of two classes, viz., the great and powerful, in whose hands the property of the country was accumulated, and the mass of the people who were generally very poor. Thus, the manufactures which were necessarily adapted to the use of these two classes generally consisted of ornaments and exquisitely fine fabrics of cotton for the use of the wealthy classes, and of coarser stuffs for the ordinary population. When the first European traders reached the coast of India in the 16th century they found a civilisation at least as highly advanced as their own; for in architecture, in fabrics of cotton and silk, in goldsmiths' work and jewellery, the people of India were then unsurpassed. But since then the East has stood still, as regards manufactures on a great scale, and the West has advanced by gigantic strides; so that while, on the one hand, the downfall of the native courts deprived the skilled Indian workman of his chief market, the English capitalist, on the other hand, has enlisted in his service forces of nature, against which the Indian village artisans in vain try to compete. Thus, many of the minor handicrafts of India have been crushed and superseded.

Historically, the most interesting of all Indian industries are the simple crafts conducted in every rural hamlet; but, before I mention any of them, it may be of interest to remind you of a fact to which I have already alluded, viz., that in India there are peoples, but not a *people*. These peoples are divided into sections by caste, which defines what a man must do and what he must not do. This is a very different thing from our own social distinctions, inasmuch as in England caste is not absolutely essential to the national life, while in India it is a part and parcel of it; for without it Hindu society would break up, and is, in fact, breaking up wherever its power is diminishing. Properly speaking, the Hindus are divided into four great castes, viz., *Bráhmins* or priests; *Rájpoots*, called also *Kshátriyas*, the military class; *Vaísyas* or merchants, bankers, and traders; and *Súdras* or agriculturists, artisans, and shepherds. But, as a matter of fact, every separate trade, profession, or occupation constitutes a distinct caste, and each such caste has its subdivisions. These people mix together in the streets and are on friendly terms with one another, but socially they are as distinct as though they belonged to different worlds, for they neither intermarry, nor eat and drink together as we do.

I need not occupy your attention with any description of these great caste subdivisions, but I may mention, generally, that the Bráhmins extend all over India, and are both respected and feared by the people at large; that the Kshátriyas or Rájpoots approximate largely to the Bráhmins and wear the sacred thread as they do; that the Vaísyas care little for Government service, but confine their attentions to the acquisition of wealth; and that the Súdras, or agricultural class, form the backbone of the country—their sole possession, in many cases, being one bullock, and a plough that consists of two rude sticks with an iron spike at the end. The artisan section of this caste is generally called Kámárthí; and as it is supposed to contain five descriptions of artisans, viz., goldsmiths, blacksmiths, coppersmiths, carpenters, and masons, it is also called Panchála, or five. Thus, the weaver, the potter, the goldsmith, the blacksmith, the brazier, and so on, are integral members of a community, as well as inheritors of a family occupation; and simplicity of life and permanence of employment are here happily combined with a high degree of excellence in design and of honesty in execution.

To enumerate the many special fabrics which are still produced in various parts of the country is hardly necessary on the present occasion; but I may mention that the fine muslin industry for which India was at one time so famed, is now a thing of the past; and that many of the weaving communities have been transferred to agricultural employments.

Silk weaving is a common industry everywhere, although Bengal is at present the only part of India proper where the rearing of the silkworm on mulberry (grown over 80,000 acres of ground) can be said to flourish; the exports under this head averaging about £800,000 annually. Embroidery is also a common industry. To mention two sections of it only; we, in England, are now accustomed to the well-known *choga*, which has recently come into popular use for dressing gowns, made of *patu* or camels' hair, and embroidered in Kashmir, the Punjaub, and Sind. The still better known Kashmir shawl, made either in Kashmir, or at Ludiana in the Punjaub, is composed of *pashmina*, or the soft wool of the so-called shawlgoat which is a native of the Himalayan plateaux.

Cotton weaving is a very ancient industry of India; and here, it may be incidentally mentioned that the great name for cotton fabrics, "sindon," is etymologically the same as that of India or Sind; while, in later days, Calicut, on the Malabar coast, has given us the word "calico." In delicacy of texture, in purity and fastness of colour, and in grace of design, Indian cotton fabrics may hold their own against the world; but, in matters of cheapness, they have been unable to face the competition of our Manchester.

Carpets and rugs may be classified into those made of cotton and those made of wool. The former, called *satrinjis* and *daris*, are made chiefly in Bengal and Northern India, and we may see many of these rugs, striped with blue, red, and chocolate, in London shops, and in English tents and houses. The woollen or pile carpets, known as *kâlin* and *kalicha*, have attained much popularity in this country by reason of the low price at which the outturn of the jail manufactories can be placed in the market. Velvet carpets are also made in Benares and elsewhere, and silk pile carpets at Tanjore and Salem. The common rugs, produced in enormous quantities from the jails at Lahore, Jabalpore, Mirzapur, Benares, and Bangalore, sell in England at very low prices.

Gold and silver and jewels have hitherto been the favourite materials for Oriental ornaments. Of this work perhaps the best known in England are (*a*) the goldsmiths' work of Kashmir, in which airy shapes and exquisite tracery, graven through the gilding to the dead white silver below, and softening the lustre of the gold to a pearly radiance, give a most charming effect to this refined and graceful work; and (*b*) the hammered *repoussé* silver work of Cutch, which, although now entirely naturalised, is said to be of Dutch origin.

Precious stones are lavishly used by Indian jewellers, who care less for their purity and commercial value than for the general effect produced by a blaze of splendour; but nothing can exceed the skill and artistic feeling with which gems are used in India, both in jewellery proper and in the jewelled decoration of arms and jade.

Iron work has attained high excellence, especially in the manufacture of arms. Both firearms and swords are often damascened, or hammered, in gold, and covered with precious stones. *Koft* work is chiefly practised in Kashmir, and in the Punjaub. The process consists of encrusting gold upon the surface of the harder metal. Damascening in silver, which is chiefly done upon bronze, is known as *bidri* work, from Bider, the ruined capital of the Nizam's dominion. Benares enjoys the first reputation in India for work in brass and copper, which is turned out also in other parts of India in large quantities. But the demand for enormous quantities of brass work at low prices for the London market is rapidly deteriorating both the design and workmanship of Indian brass work, and the native workman finds that vulgar patterns, hastily carved, command a ready sale, while their old faithful, but more expensive, work can scarcely, alas, attract an English customer.

Next, after the loom of the weaver, the potters' wheel is the characteristic emblem of an ancient civilisation. Pottery is made in almost every village in India; but it has hardly yet risen to the dignity of a fine art, except perhaps in Sind. Efforts have been made by the Bombay School of Art to foster this industry, but, as in other cases of European patronage, the Indian artisan loses his originality when set to copy alien patterns,* and it would be well if European manufacturers were to follow more faithfully the advice given to them by Sir George Birdwood, "not to slavishly plagiarise, but to receive into their breasts a stimulating and elevating influence from the light and life of a traditional art still fresh and pure, as at its first dawning three thousand years ago, on the banks of the Indus, the Sáraswatí, and the Ganges."

Wood-carving in Western India is carried to a high degree of excellence. Black wood is used for highly decorative objects which have attracted attention in England from their excess of elaboration; and sandal wood, which comes from the forests of the western Ghats in Kanara and Mysore, affords material for fine carving. Akin to wood-carving is the inlaying of the articles known as Bombay boxes. These are produced by a process of binding together, in geometrical patterns, strips of tin wire, sandal wood, ebony, ivory, and stags' horn. At Vizagapatam, in Madras, similar articles are made of ivory and stags' horn, with scroll work edged in to suit European taste.

To pass from these native art-industries to the manufactures of the mills founded by English capital, is at once to pass to a new world, so to say, of rapidly developing importance. Speaking briefly, there are now 144 cotton mills (containing 34,000 looms, and 3,700,000 spindles) in India, of which 100 are in the Bombay Presidency alone. These employ 140,000 hands. There are also 29 jute mills (with 10,000 looms and 200,000 spindles), employing 75,000 hands; and 2,500 rice, paper, tobacco, and other mills and factories of sorts, which employ some 300,000 more of the industrial population. Breweries also, of which there are 22 in India, are in a flourishing condition.

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* Mention may here be made of the S.E.P.I.A., or Society for the Encouragement and Preservation of Indian Art, founded in London, in 1890, under the auspices of Mrs. David Carmichael. The object of this society is to foster the indigenous decorative arts of India, and to preserve their distinctive characteristics. It also aims at encouraging the artisans in every province of that country to continue in the practice of their hereditary handicrafts, notwithstanding the pressure of the commercial competition to which they are being subjected through the great development of trade between the West and East, and the inducements that are often held out to them to copy unsuitable and incongruous Western designs. It also endeavours to extend among European purchasers a taste for genuine Indian art work, and to enlist the sympathy and support of the Indian chiefs and princes, and others, in preserving the local arts and decorative handicrafts of the several states and provinces in that country. No doubt it will pay attention, also, to the development of Eastern designs that are not mere oft-repeated copies of old ones.

As to the cotton mills of India, it has to be borne in mind that the cotton grown in that country being what is known as "short-stapled," cannot be spun into the finer kinds of yarn in any quantity, but only admits of the Indian mills turning out, as a rule, lower counts of yarn, and the coarser fabrics of piece goods. Thus Manchester still possesses some advantage in the supply of higher counts of yarn used by the hand-loom weavers of India, and in the superior qualities of cloth. But, as you all know, in order to give the mother country a fair chance in the cotton trade, the Government of India now apply duties on cotton to Indian and imported goods equally. Thus (*a*) woven goods only are now dutiable, and all yarns are free; (*b*) the duty imposed is the same for all counts, coarse and fine; (*c*) the rate of duty is reduced from 5 per cent. to 3½ per cent. But, at the same time, no excise duty is imposed on hand-loom industries.

In regard to the *commerce* of India; I may perhaps be allowed, in the first instance, to remind you of the fact that commerce, in its general sense, implies the exchange of articles of any kind for money or other commodities; of which we have the earliest written notice in Scripture, where we read of a company of Ishmaelites or Arabs (to whom Joseph was sold by his brethren) going to Egypt with spices, balm, and myrrh, carried on the backs of camels, for the purpose of exchange and barter.

I do not propose to refer to this branch of my subject in much detail, but I will content myself with a few general remarks which may not be without interest. Sir William Hunter, in some of his admirable works on India, has reminded us that it is well to clearly apprehend the function which commerce has now to perform in that country. The people have in some provinces outgrown the food-producing powers of the soil; in many others they are pressing heavily upon those powers. Agriculture, once their sole industry, no longer suffices for their support, and new industries have become a necessity for their well being. Commerce and manufactures have, therefore, obtained an economical importance which they never had before in India, for they represent the means of finding employment and food for the rapidly increasing population.

A large external trade was an impossibility under the Moghul emperors for want of proper communications; and the manufactures of India were, essentially, domestic industries conducted by special castes in each town and village. But one of the earliest results of British rule was the growth of great mercantile towns, and an era of production on a great scale, based upon co-operation of capital and labour. Thus, before the English became the ruling power in India, the country did not possess £1,000,000 a year of staples for exportation. She now sells to the world about £70,000,000 worth of such staples, viz, of cotton, jute, rice, wheat, tea, and so forth; and taking merchandise alone, the average value of India's trade with England is some £22,000,000 sterling, or about one-third of her total exports. The internal trade of India greatly exceeds her foreign commerce, although it is difficult to estimate its amount. It remains, broadly speaking, in native hands, so far as the work of distribution and the adaptation of the supply to the demand of the consumer are concerned.

In the interior of the Bombay Presidency, business is mainly divided between the Banias of Guzerat and the Marwaris from Rajputana, each of whom profess a peculiar form of religion. In the Deccan their place is taken by Lingáyats from the south, who are also found throughout Mysore and in the north of Madras; but along the eastern seaboard the predominating classes of traders are the castes named Chettris and Komatis. In Bengal, however, many of the upper classes of Sudras have devoted themselves to wholesale trade; although here also the Jain Maiwáris from Rajputana and the north-west occupy the front rank; for they penetrate everywhere among the wild tribes, even up to the unexplored frontier of China; and it is said that the natives of the Khàsi hills are the only hillmen who do their own business of buying and selling. In the North West Provinces and Oudh the traders are generically called Banias, and in the Punjaub are found the Khatias, who have perhaps the best title of any to regard themselves as descendants of the Vaisyas, or original caste of cultivators.

Thus the commerce of India, of which this is only an imperfect outline, is of an interesting character and of increasing importance; and having already mentioned the extent of Indian exports to Great Britain I may here add that she receives imports from the mother country amounting to about £28,000,000 annually, by which we may see at a glance that, viewing the matter from a commercial point of view only, the ties that connect the two countries are of great value to both. Fifty years ago the whole trade of Great Britain with the East did not amount to more than £20,000,000 sterling. To-day it is equal to at least three times that amount, and is carried by merchant fleets* which do honour to British enterprise and British progress.

And now I must close this address, regretting that the limit of time so wisely prescribed for us on these occasions has compelled me to deal very cursorily with the subject of India and its arts, manufactures, and commerce, and to leave unmentioned those of that still greater world, our splendid Colonial empire, in which this Society takes also so deep an interest. Long may India remain a gem in the crown of our beloved Sovereign, under whose lengthened and beneficent rule it has made so much progress and has received so many benefits! Long may the East and the West meet in friendly competition and comradeship, each receiving from the other what each has so much to give to the other!

At the same time I may repeat an old word of caution as to the capabilities of the country which we all hold in such high esteem. Men have naturally a strong disposition to contemplate the past or the distant through a magnifying medium, and to believe what the confident assertions of others, or the love of wonder in themselves, suggests with regard to fabulous wealth. Hence arise the statements so often brought forward in regard to the immemorial wealth of India, and the rapidity with which fortunes may still be made there; and it has required some years to discover, that if we make allowances for deaths, and for disappointments from various causes, the proportion of those who succeed in India is not great; and that a fortune, when it does happen to be made, is the result of length of time, of a habit of saving favoured by exceptional circumstances, of rare political contingencies, or, finally, of unusual opportunities.

No doubt at one period of the modern history of India, some men made large fortunes; for it was a common practice of the company's servants to enrich themselves at the expense of their masters by monopolising all the inland trade, and by compelling the oppressed inhabitants both to purchase and to sell at prices fixed by themselves. But all this is now changed; and although India still offers a good field for enterprise, success, and progress, it is, after all, a poor country, struggling with debt and other difficulties. These test the statesmanship of the men who are at the helm, without placing much wealth in the pockets of our civil, military and uncovenanted services, who have handed down to posterity, notwithstanding all manner of shortcomings, failures and errors, the greatest and most memorable of our imperial possessions. Nor may we forget, when speaking of this magnificent inheritance of the British people, those many loyal native princes, statesmen and gentlemen of successive generations, of whom we are all proud; men who are allied to us in one common bond of brotherhood, under a Sovereign, to whom Homer's noble ascription to Arete* so aptly applies; honoured from the heart both by dear children and the people, lacking nothing of sound sense and judgment, and healing strife among those She loves and rules.

I have now the pleasing duty of presenting the Society's silver medals awarded during the last Session.

For papers at the Ordinary Meetings:—

To W. J. Dibdin, F.C.S., for his paper on "Standards of Light."

Mr. Dibdin has taken a prominent part in the various attempts to establish a satisfactory standard of light, and in this paper, in continuation of others, he described the latest

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[*] Foremost among these great merchant fleets may be named the Peninsular and Oriental Company, which was founded in the year (1837) of the Queen's accession to the Throne. Commencing with a paddle-boat of 206 tons and 60 horse-power, this company now possesses a fleet of 59 steamers (some of which are, in size, 8,000 tons and 11,000 horse-power), running a mileage of 2,600,000 miles a year, and carrying the mails to and from the East with rapidity and safety. Only 20 years ago the mails between London and Bombay took upwards of three weeks in transit; but to-day the work is done in 280 hours, or less than twelve days. The Peninsular and Oriental Company has passed through many vicissitudes of fortune, but, under the able guidance of Sir Thomas Sutherland, M.P., it has now reached a position among the merchant fleets of the world of which this country may be proud.

[*] Homer's Odyssey. Book vii., line 67-74.

Ὥς κείνη περὶ κῆρι τετίμηταί τε, καὶ ἐστὶν,
Ἔκ τε φίλων παίδων ἔκ τ᾽αὐτοῦ Ἀλκινόοιο,
Καὶ λαῶν, οἵ μίν ῾ρα, θεὸν ὥς, εἰσορόωντες,
Δειδέχαται μύθοισιν, ὅτε στείχῃσ᾽ ἀνὰ ἄστυ.
Οὐ μὲν γάρ τι νόου γε καὶ αὐτὴ δεύεται ἐσθλοῦ
Οἷσίν τ᾽ εὖ φρονέῃσι, καὶ ἀνδράσι νείκεα λύει.

experiments with his improved burner, for the production of a pentane air flame such as was first proposed by Mr. Vernon Harcourt.

To A. J. Hipkins, for his paper on "The Standard of Musical Pitch."

The Society of Arts has long taken a special interest in the adoption of a uniform pitch, and welcomes from so great an authority as Mr. Hipkins this able argument in favour of the general adoption of the French pitch.

To A. A. Campbell Swinton, for his paper on "Röntgen's Photography of the Invisible."

The marvellous phenomena discovered by Professor Röntgen were demonstrated to the Society by Mr. Swinton with admirable effect very shortly after their discovery, and his paper attracted considerable attention and interest.

To Dr. D. Morris, C.M.G., M.A., for his paper on "Bahamas Sisal Industry."

Dr. Morris, who has on several previous occasions favoured the Society with valuable papers and lectures respecting the fibre industries, well illustrated in this paper the importance of this new fibre plant, which is largely grown in the Bahamas.

To Edward W. Badger, for his paper on "Fruit and Vegetable Drying."

The system of artificial drying applied to fruit and vegetables is very generally adopted in the United States, and Mr. Badger clearly showed the value to the British farmer of the system by which large quantities of fruit and vegetables may be saved in times of plenty.

To E. W. Moir, M.Inst.C.E., for his paper on "Tunnelling by Compressed Air."

In this paper, Mr. Moir gave an admirable account of the works connected with Blackwall Tunnel, which was under his superintendence, and of the difficulties overcome during its construction, as well as a description of subaqueous tunnelling since Brunel first employed a shield in the construction of the Thames Tunnel.

In the Indian Section :—

To Colonel R. G. Woodthorpe, C.B., R.E., for his paper on "The Shan Hills: their Peoples and Products."

Colonel Woodthorpe had special opportunities, as a member of the Burmese Delimitation Commission, of exploring this remarkable district, and he gave the Society a vivid picture of its present condition.

To J. H. Glass, C.I.E., for his paper on "The Great Landslip at Gohna, in Gurhwal, and the Measures adopted to Prevent Serious Loss of Life."

This paper, on a great convulsion of nature in India, and the precautionary engineering measures which prevented an enormous loss of life, was one of the most important papers read before the Society.

To G. W. Christison, for his paper on "Tea Planting in Darjeeling."

Mr. Christison is well known as an Indian planter, and his practical account of the work done in the district of Darjeeling was of great value and interest.

In the Foreign and Colonial Section :—

To Frank Cundall, for his paper on "Jamaica in the Past and Present."

Mr. Cundall in his excellent paper gave an exhaustive account of the chief island of the British West India group.

To G. Scott Elliot, for his paper on "The Commercial Prospects of English East Africa and British Central Africa."

These territories, as a centre of British commerce, must ever be a subject of interest to Englishmen, and Mr. Scott's useful paper on this was specially noticeable, on account of his reference to the portions of Africa which might be found to be suitable for European settlement.

To Charles R. Valentine, for his paper on "The Colonies and the Supply of Dairy Produce and Products of Petite Culture."

We owe to Mr. Valentine a most exhaustive account of the means taken to supply this country with food from its own colonies.

In the Applied Art Section :—

To Gleeson White, for his paper on "The Poster and its Artistic Possibilities."

In his interesting paper on a subject which has attracted much attention of late years, Mr. Gleeson White showed how great has been the advance in the artistic treatment of the poster in this and other countries.

To William Burton, F.C.S., for his paper on "The Palette of the Potter."

This paper contains a remarkable account of the masterly use of colour by the potter in all ages of the world.

To George Simonds, for his paper on "Bronze Casting in Europe."

Mr. Simonds, who on a previous occasion had read before the Society a paper on "Artistic Bronze Casting," gave a graphic account of the operations necessary for the casting of bronze statues.

The thanks of the Council were also voted to the following members of the Council:—

To **Prof. W. Chandler Roberts-Austen**, C.B., F.R.S., for the paper by himself and Mrs. **Lea Merritt** on "Mural Painting, by the Aid of Metallic Oxides."

To **Capt. W. de W. Abney**, C.B., F.R.S., for his paper on "Orthochromatic Photography."

Sir **Frederick Abel**, Bart., K.C.B., F.R.S., said many successive chairmen of Council had delivered interesting and important addresses, but he thought none had been listened to with greater pleasure and interest than the charming one just given by Sir Owen Burne. He was a man who had had half a life's experience of that land of romance in the East to which they were all attached by numerous traditions, and all the more so when they thought how large a feature it was in the British Empire. Those who, like himself, could remember the old East India Company, in looking back, could not but be struck with the wonderful progress which had been made since its day in the development of the vast Indian empire. Thanks to Sir George Birdwood and others whom he saw present, the people of this country had been made more or less acquainted with India. In the Indian Section of the South Kensington Museum, and again, in a minor degree, at the Imperial Institute, there were presented objects, showing, to some extent, the resources of India, and its position with regard to industry and commerce, present and future. Some of its art treasures were also displayed, and there could be no more interesting study than that of the native art of India. It was a wonderful example of minuteness of work, of industry and perseverance; and if there were any matter of regret in connection with it, it was to see European forms imitated in India at the present day. One would much rather see the natives of India adhere to the old forms, beautiful, chaste, and quaint at the same time. He certainly considered the society to which Sir Owen Burne had referred—the Society for the Encouragement and Preservation of Indian Arts—deserved the thanks, not only of England, but of India, for the way in which it was throwing itself into the work of endeavouring to maintain the true art conditions in British India. He had much pleasure in proposing a hearty vote of thanks to Sir Owen Burne for his address, which he took to be an indication of the good work he was about to do as Chairman of the Council during the coming year.

Sir **Douglas Galton**, K.C.B., F.R.S., seconded the motion with much pleasure, and said he was sure all present would agree with Sir Frederick Abel as to the great interest of Sir Owen Burne's address.

The motion was put to the meeting by Sir **Frederick Abel** and carried unanimously.

Sir **Owen Burne** briefly responded, saying it always gave him great pleasure to speak about India, which was an endless subject of interest to him, and one which it would take a long time to exhaust.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian B. Lewes, "The Use of Gas for Domestic Purposes." (Lecture I.)

Scottish Society of Arts, Royal Observatory, Blackford-hill, Edinburgh, 8 p.m. 1. Mr. Thomas Heath, "Notes descriptive of some of the Astronomical and Physical Instruments of the Royal Observatory, Edinburgh." 2. The Observatory will be shown in its working order.

Imperial Institute, South Kensington, S.W., 8½ p.m. Prof. Judd, "Rubies, Natural and Artificial."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. Walter C. Ryde, "The Agricultural Rates Act, 1896."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Lieut. Seymour Vandeleur, "Two Years in Uganda, Unyoro, and the Upper Nile Region."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. A. Hill, "Cresco Films."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. W. Knight, "The Function of Philosophy at the Present Day."

Tuesday, Nov. 24...Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Photographic, 12, Hanover-square, W., 8 p.m. Mr. R. Child Bayley, "A Photographic Museum."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Wednesday, Nov. 25 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. Worby Beaumont, "Recent Developments in Mechanical Road Carriages."

Geological, Burlington-house, W., 8½ p.m. Reception.

Royal Society of Literature, 20, Hanover-square, W., 1 p.m.

British Astronomical, University College, Gower-street, W.C., 5 p.m.

Thursday, Nov 26...Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C , 6 p.m. Dr. T. Hodgkin, "Ravenna and its Mosaics."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Renewed discussion on Mr. Cavey's paper, "The Telephone Trunk Line System of Great Britain."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. W. Law Bros., "Dalmatia."

Friday. Nov. 27...Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Special General Meeting. 2. Capt. Abney, "Apparatus for giving Diagrams of the Efficiency of a Photographic Shutter."

Saturday, Nov. 28—Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

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FRIDAY, NOVEMBER 27, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

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JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 6 and 13, 1897, by Clinton T. Dent, F.R.C.S., Past President of the Alpine Club, on "The Growth and Demolition of Mountains." The lectures will be fully illustrated with lantern slides and experiments. After a brief sketch of the growth of mountains, the following points will be discussed in the course:—The agencies which contribute to the demolition; wearing and weathering of rock; protective and destructive influence of glaciers; avalanches—the Altels avalanche in 1895—mountain falls—bursting of glacial lakes.

The lectures will commence at seven o'clock. Special tickets are required for these lectures, which can be obtained on application to the Secretary. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. The cards are now ready for issue.

EXAMINATIONS COMMITTEE.

A meeting of the Examinations Committee was held on Monday, 23rd inst., at 4 p.m. Present: Major-General Sir John F. D. Donnelly, K.C.B., in the chair; Captain W. de W. Abney, C.B., F.R.S., M. Carteighe, R. Brudenell Carter, F.R.C.S., Charles Critchett, Francis Elgar, LL.D., F.R.S., Sir Douglas Galton, K.C.B., F.R.S., Sir Philip Magnus, Gilbert R. Redgrave, Sir Owen Roberts, D.C.L., with Sir Henry Trueman Wood, Secretary of the Society.

CANTOR LECTURES.

On Monday evening, 23rd inst., Prof. Vivian B. Lewes delivered the first lecture of his course on "The Use of Gas for Domestic Lighting."

The lectures will be published in the *Journal* during the Christmas recess.

Proceedings of the Society.

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SECOND ORDINARY MEETING.

Wednesday, November 25, 1896; Sir Frederick Bramwell, Bart., D.C.L., F.R.I., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Browne, Major Alexander H., Callaly Castle, Whittingham, R.S.O., Northumberland.
Carter, George Henry, 65, Torriano-avenue, Camden-road, N.W.
Walsh, Thomas M., Tuam, Co. Galway, Ireland.

The paper read was—

RECENT DEVELOPMENTS IN MECHANICAL ROAD CARRIAGES.

By W. Worby Beaumont, M.Inst.C.E.

Since I last had the honour of addressing the Society of Arts* on this subject, the most important development has been that of public opinion, which has forced upon the Legislature the necessity for the removal of the restrictions which until now have effectually prevented the development of road traction, and of carriage by mechanical means on the common roads of the United Kingdom. British engineers were fined for running a motor tricycle for experimental purposes on our roads at a speed of more than two miles per hour unless preceded by a man on foot to clear its way, until the 14th of November, 1896, the day on which the Locomotives or Highways Act of 1896 came into force. The long existing and extremely absurd restrictions against travelling over the country by mechanical means must ever be regretted, not simply because of the injury to those who would have reaped the benefit of me-

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* Cantor Lectures—December, 1895.

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chanical transport for trading purposes, but because of the prohibition of all experimental running, which prevented British engineers from developing the steam or other road carriages, the construction of which might by this time have formed a greater industry than it has already done in the hands of our unrestricted competitors abroad. The result is that everything towards the construction of light motor vehicles has now to be commenced, while for a foreign trade other countries are now two years ahead of us.

All this is to be regretted but it is past, and there now only remains a few restrictions which the lapse of a very few years will probably see removed from the Local Government Board list of regulations. Those regulations have in general the assent of the motor carriage building and using public, but there are some which are of the nature of dictates to mechanical engineers who on such structural detail as reversing gear, brakes, and wheels, should be left to provide that which they, by past or coming experience, know or will find is best.

A year ago the modern mechanical road carriage, as distinguished from the steam boiler and engine vehicles with a few seats attached, made in England between 1858 and 1876, was almost entirely the French and German ordinary carriage driven by a Daimler or a Benz petroleum spirit motor. Several of these were in their more developed forms the product of the incentive in the form of prizes offered by the French *Petit Journal*. For those prizes it will be remembered vehicles ran from Paris to Bordeaux and back, several of the carriages doing some remarkably creditable running. The most striking feature of the results of those trials was the defeat of the steam vehicles by those driven by petroleum spirit motors, although in previous shorter races the steam vehicles had given much promise.

In September last a race by mechanical road carriages, organised by the Automobile Club, of France, took place from Paris to Marseilles and back, a total distance of 1,070 miles. The character of the gradients may be gathered from the diagram on the wall, which gives the whole road from Paris to Marseilles on a horizontal scale of 1 to 83333, and a vertical scale of 1 to 1250.

Three classes of vehicles were entered: (1) Those with two, three, or four seats; (2) vehicles with more than four seats; and (3) motor cycles.

Among these were three steam vehicles, one a Dion and Bouton tractor, with attached carriage; one a Chasseloup - Laubert steam omnibus; and the other a Dion and Bouton steam brake. A steam carriage, to be drawn by a rotary engine, was entered, but did not appear. Of the remaining thirty-two vehicles which started in the race, twenty-nine were petroleum-spirit motor vehicles, five of them being tricycles.

The race run by these vehicles and motor cycles was a very severe test of their capacities, although they were not allowed to run through the night, and were allowed, under supervision, to make any necessary repairs. The weather, during a greater part of the run, was of the worst description, and the incidents included hurricanes which strewed the roads with tree branches, and even trees. The motor cycles of Dion and Bouton did remarkably well in spite of the condition of the roads.

The total time occupied by the fastest vehicle was 67 hours 42 min. 58 sec. The following list shows the numbers of the vehicles as entered for the competition, the name of the maker or inventor, and the running time occupied in covering the 1,728 kiloms. or 1,070 miles, from Paris to Marseilles and back:—

No.		H.	M.	S.
6.	Panhard and Levassor....	67	42	58
8.	Panhard and Levassor....	68	11	5
13.	Dion tricycle...........	71	1	0
5.	Panhard and Levassor....	71	23	22
51.	Dion tricycle (entered by Michelin)	73	30	12
46.	Peugeot	75	26	24
41.	Delahaye	75	29	48
44.	Peugeot	81	23	51
15.	Dion tricycle...........	83	6	16
42.	Delahaye	84	27	5
29.	Maison Parisienne	100	41	37
30.	Maison Parisienne	108	39	48
26.	Landry and Beyroux	137	11	17

The average speed of the No. 6 Panhard and Levassor carriage was thus 25 kiloms. 525 metres, or 15·85 (or nearly 16) miles an hour.

In Class 1 the prizes were awarded as follows:—1st, No. 6, Panhard and Levassor; 2nd, No. 8, Panhard and Levassor; 3rd, No. 5, Panhard and Levassor; 4th, No. 41, Delahaye; 5th, No. 44, Peugeot; 6th, No. 42, Delahaye; 7th, No. 29, Maison Parisienne; 8th, No. 30, Maison Parisienne; 9th, No. 26, Landry and Beyroux. In Class 2 only one vehicle qualified, and the first prize went to No. 46, of Peugeot and Company. In Class 3 (the motor cycles) the prizes were given as follows :—1st, No. 13, Dion tricycle ; 2nd, No. 51, Dion tricycle (entered by M. Michelin) ; 3rd, No. 15, Dion.

It may be mentioned that in the run home the 120 kiloms. between Sens and Paris were covered in the following times :—No. 51, tricycle, 4 h. 55 m. 34 s. ; No. 13, tricycle, 4 h. 59 m. 6 s.; No. 8, Panhard and Levassor, 4 h. 59 m. 40 s. ; No. 5, Panhard and Levassor, 5 h. 1 m. 35 s.; No. 39, Bollée vehicle, 5 h. 6 m. ; No. 41, Delahaye, 5 h. 6 m. 30 s. ; No. 44, Peugeot, 5 h. 28 m. 16 s. ; No. 46, Peugeot, 5 h. 32 m. 15 s. ; No. 6, Panhard and Levassor, 5 h. 42 m. 15 s. ; No. 42, Delahaye, 6 h. 5 m. 30 s. ; No. 15, Dion tricycle, 6 h. 28 m. 10 s. ; No. 26, Landry and Beyroux, 7 h. 8 m. 30 s. ; No. 30, Maison Parisienne, 8 h. 12 m. 25 s. ; No. 29, Maison Parisienne, 8 h. 12 m. 25 s.

That any motor carriages could, under racing conditions, cover 1,070 miles, at an average, for the running time, of nearly 16 miles per hour, shows that even allowing for slight repairs, these vehicles have reached a considerable state of efficiency. Under ordinary working conditions there is no doubt many more would have performed the journey with complete success, and whatever may be said to the contrary, there can now be no doubt that the motor carriage has passed from the stage of mere experiment to the position of a carriage and mechanism only requiring continued experience to show what are the requirements in a perfectly practicable, trustworthy vehicle. Some of the lessons to be learned from this race will be referred to hereafter, although race conditions are not necessarily those which best show the qualities of motor carriages, or any other mechanically operated thing, for daily ordinary uses.

In November of last year, competitive trials of a few motor carriages were carried out in accordance with rules laid down by the engineers appointed by the proprietors of the Chicago *Times Herald* to award the prizes offered by them for the best vehicles. The conditions of these trials were well thought out, and the trials included tests of the motors, their tractive power and fuel consumption. They were thus much more complete than the mere race conditions in France. The time allowed for the preparation of vehicles from the day the prize offer was announced, was, however, very inadequate, and the result was that only six vehicles were presented for trial. The weather and the roads were exceptionally bad, and the trials were almost fruitless. The greatest distance run was under 55 miles, and that by only two vehicles, others running only from 4 to 40 miles. The three which accomplished the greater distances were worked by benzoline or petroleum spirit motors, one of them being the Benz motor used in the Roger carriages, and others of similar kind. The two best were the Duryea and the Mueller, the arrangement of the former being that shown on the screen. These vehicles have achieved considerable success, and one of them took part in the run on the 14th inst. from London to Brighton.

Turning now to the lessons of the Paris-Marseilles race, it will first be noticed that no steam vehicles were present ; all these long distance runs were made by benzoline motors. The well-known Serpollet carriages were not even entered, although they had done so well in the *Petit Journal* competition in 1894 and 1895, and attracted much attention, when shown in the Hurlingham grounds and in the recent Crystal Palace exhibition.

In these competitions there were other steam carriages by Scotte, and by De Dion and Bouton. In 1894 the second prize was awarded to the latter firm for their steam tractor or steam bogie, and the third prize was awarded to M. Le Blant for a steam carriage for nine persons, fitted with a Serpollet boiler. It is thus evident that the continental motor carriage builders with their now very extensive experience in this matter have found the construction of a steam motor carriage a much more difficult problem than the construction of one operated by benzoline or petroleum spirit. One of the first difficulties is the much greater weight of the steam carriage, almost all of which is due to the weight of the boiler and its connections, and also to the weight of the supply of fuel and water required for a journey of any distance. The steam motor itself may be very light indeed and yet sufficient for the purpose. The Serpollet instantaneous generation boiler seemed at one time to be likely to meet the requirements of this essential part of the equipment of a steam motor carriage, and but for the weight of it and its case, and the coke fuel, there is no doubt it would, and it seems probable even yet that with certain modifications it may provide all that is required. The boiler, as is well known, is built of tubes having exceedingly small water capacity as compared with their thickness and weight, as is shown by the view on the screen.

Now, in connection with the use of steam under the circumstances of very variable demand, as in the case of the motor carriage, there is no doubt very distinct advantage accruing from the use of heavy thick tubes carried within a refractory case and heated by a powerful coke fire, because the mass of heated material constitutes a very effective heat accumulator capable of instantaneous conversion on demand. The frequent stoppages, the easy work on level roads, the complete absence of work in going down hill, all are conditions which make a heat accumulator steam generator with small water capacity desirable, and especially as such a generator will respond to the sudden call for a quantity of steam for starting or for climbing short hills largely in excess of its mean capacity. But there is nothing mysterious about the capacity or performance of such a boiler, and it has to be remembered that the steam required for mounting a long hill gives the measure of the boiler capacity required. When the accumulated heat in the mass of material forming the tubes has been used up during the mounting of a hill, then the Serpollet boiler, like any other, depends upon the quantity of its heating surface and upon the amount of fuel which can be effectively burned in heating it or, in other words, upon the grate surface and draught or fuel burning capacity. It is from this cause that the Serpollet boiler as made in 1894 and 1895 was heavy for ordinary easy road travelling though very efficient for the purpose when it was made with sufficient surface for long hill climbs. More than a year ago M. Serpollet ceased for a time to give his attention to his steam carriage so as to enable him to develope the application of his system to mechanically propelled tramcars with which he has attained considerable success.

Whilst he has been so engaged very little progress has been made in France with steam for road traction. His old vehicle was not suited to everyday use. It could only carry a supply of coke for a run of from 40 to 50 kiloms., or from about 25 to 30 miles. It attained high speeds on level roads or easy gradients, was handy to drive, and economical, but it was cumbrous and heavy, and coke was not a pleasant fuel to use. The steam tricycle constructed in 1889 also used coke. The generator weighed 350 kilos. with the fuel.

The vehicle more lately constructed runs on three wheels, the rear wheels serving for propulsion, and the front bicycle wheel for steering. The generator is placed at the back of the carriage, and the two-cylinder motor, inclined at 90 deg., is under the seat, bolted to the steel tube underframe which curves up in front for the steering head. The crankshaft carries a pinion which gears into a large wheel on the driving axle, so that the usual intermediate gearing is dispensed with. For fuel, petroleum is now used, a Longuemare burner being employed. The ordinary lamp petroleum is admitted at the bottom of the burner and is forced up through a spiral tube, where it volatilises under the heat of the flame, and descending to the bottom of the burner, passes through a form of metallic filter to relieve it of impurities. It then enters a chamber, from which it passes through small holes into a second chamber containing eight jets, through which it issues as petroleum vapour and burns with an intense flame, spreading out to cover the whole area of the funnel formed by the spiral tubes, and space, above it containing the Serpollet steam generator. The burner is started in the ordinary way with a little methylated spirit, and in from eight to twelve minutes the machinery is said to be ready for starting.

The new three-wheeled carriage is merely an experimental one. It was not intended to do any serious work, and yet it has already, it is stated, run more than 1,000 kiloms. They say that they can run at higher speeds than have yet been attained. They can run easily at 35 kiloms. an hour, and even in going up the Suresnes hill, which is particularly long and steep, they can go at 25 kiloms. Everything is tested in France by speed of travelling. The speed can, with steam, of course be regulated with precision, and with the power this carriage appears to have there is no necessity for mechanism for changing speed. The speed mentioned is, however, unnecessary, and its possibility shows that the boiler and engine are larger than necessary. In the experimental vehicle a reserve of 22 litres of petroleum, and 50 litres of water can be carried. With this supply of petroleum the carriage has run from Paris to Rouen—about 140 kiloms., or 87 miles—without replenishing the oil. The time occupied in covering the distance was, I am informed, six hours. The weight of the carriage without load is 700 to 800 kilos, or from 14 to 16 cwt.

M. Serpollet is building a new carriage with four wheels, in which he will make certain modifications. The steam generator, instead of having circular spiral vaporising tubes, will have them arranged in a square placed one above the other, so as to obtain a larger heating surface. It will also be fitted with a condenser underneath the carriage. With this he intends to condense the steam in the winter, and return it to the boiler, so as to suppress the exhaust, and make renewal of the water supply less frequently necessary. In the summer, he says, this is of no importance, as the steam, being sent away with the heated gases, will not then be visible. The gearing is light and compact, and will be enclosed in a gear case to protect it from dust and mud.

The same system of boiler construction for oil fuel is to be applied to tramcars, the weight of the boiler being very much reduced by it.

The De Dion and Bouton boiler is a much more delicately constructed boiler, consisting as it does of an exterior annular water case, connected to a central, similarly-constructed, annular water and steam space by a large number of upwardly inclined radial and steam tubes.

One of these boilers weighing about 530 lbs. empty contains 22·75 sq. ft. of heating surface, and has a grate area of 1·86 sq. ft. It will, it is said, evaporate about 6 lbs. of water from average temperatures per lb. of coke, and yet it is said to be sufficient for an 18 horse-power motor. It thus has only about 1·26 square feet of heating surface per horse-power, and only 0·103 square feet of grate surface per horse-power. Assuming the little engine employed, which was a small compound engine, to be capable of giving a brake horse-power for 30 lbs. of steam, then it will be seen that each square foot of surface would have to evaporate no less than 23·8 lbs. of water per square foot per hour, and, further, that no less than 52½ lbs. of coke would have to be burned per square foot of grate surface per hour.

Now, inasmuch as the Serpollet boiler is not credited with evaporating 6 lbs. of water per lb. of coke, it will be readily understood that both these boilers have been very much overrated, and hence the difficulty of providing steam for full power for more than a very short time. The Serpollet mass of heated material will, of course, enable the user for a few seconds, or a minute or two, to obtain manifold the average power of the boiler on continuous load, but the store of heat is soon gone, and the boiler soon flooded if water is sent in at maximum rate. This will be easily seen when it is remembered that the latent heat of evaporation of water from, say, 62 degrees is 1,116 units, and, therefore, no less than eight times the total heat of the iron tubes, even assuming them to be at a 1,000 degrees in temperature when called upon to give up their store. If then, as appears to be the case, these two boilers are the best, or, at all events, the most favoured by those who have been working at this problem for years, it would appear obvious that the great advantages offered by the steam-engine have hitherto been unattainable because of the difficulty which besets the problem of constructing a sufficiently powerful boiler of sufficient lightness.

It is owing then to the hitherto unattainable in steam generators that the light oil motor has, as in the recent Paris and Marseilles race, displaced the steam-engine, and it is not easy to see how with the low weights possible with the oil motor anything yet known in the form of steam generators, the steam-engine with everything else in its favour can compete. It is true that success is said to have attended the trials of the Blackburn dog-cart in which a comparatively small coiled tubular boiler, heated by a Bunsen methylated spirit burner, was employed, but inasmuch as the trials of this dog-cart were made over very short distances, and the engine employed was not of high efficiency, it does not appear to have been demonstrated that this boiler was capable of generating sufficient steam for meeting the demands of ordinary road travelling. Considerable advances have been made in the last few years in the construction of water-tube boilers, and some of these boilers will no doubt generate more steam per unit of their weight than was possible with most of the boilers used in steam carriages between 1858 and 1878, or any of the boilers used in the modern light road locomotive, highly efficient as some of these are. They do not appear, however, to offer any advantage not equally secured by the boilers of Dance, Gurney, Church, Hancock, and Macerone sixty years ago*, and it is possible that some of these and the high pressure tubular boiler of Loftus Perkins may even yet, aided by the possible very high temperatures obtainable by the combustion of petroleum as fuel, yet enable us to employ the steam-engine.

It may be asked what after all are the advantages which steam offers, and we may answer this question by saying, firstly, the steam-engine affords greater range and ease of manipulation within the limits of no power and full power than any other motor; secondly, it may be stopped and started with more freedom, certainty, and smoothness than any other motor, with the exception of the electrical; thirdly, it may be employed for travelling any distances with fuel everywhere available, is easily fitted with reversing gear, and is easily understood.

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* Cantor Lectures, *Journal*, vol. xliv.

Now, as against these high qualifications there is the great disadvantage, as compared with the oil motor, of the necessity for manufacturing on the road the working fluid by means of a boiler. With the equivalent of this the oil motor is able to dispense, for even where a vaporiser is employed, or a carburettor, the weight of these parts is comparatively insignificant, and they require but little if any attention. Recent advances seem to show that even this may not in future be necessary, for, with a mixture of oils, or with a light oil or petroleum spirit, the carburettor may be dispensed with, and the vaporiser may be either rudimentary or non-existent. To this point return will be made hereafter. The chief disadvantages at present attending the use of the oil motor are firstly, the necessity for keeping the motor running while the car is standing; secondly, the vibration set up by the explosive impulse, which is very irregular, especially when the motor is running light, or nearly so; and thirdly, the necessary use of clutches and rather complicated gearing for putting the light running motor into gear, or changing the speed by means of gear. In spite of these difficulties, however, the oil motor vehicle has made such advances in details of its construction that the race from Paris to Marseilles and back was not only a possibility under adverse circumstances with vehicles of various types, but may be looked upon as a certainty for everyday purposes in the hands of people who are willing to bestow upon them their careful attention.

All the carriages of the Paris-Marseilles-Paris race were fitted with gearing very much the same as that which was, more or less, in general use by the several leading makers more than a year ago, and it does not appear that anything more than slight additional strength and improved form of clutches—by means of which the motor can be put in and out of gear with smoothness—are necessary to enable vehicles to run any length of time, as far as this detail is concerned, with satisfaction.

The carriage which won the first prize in this contest was of the Panhard and Levassor construction, driven by a light oil or benzoline motor of the Daimler type. It drove gearing by the arrangement described by the author last December, and as shown by the view now thrown upon the screen.

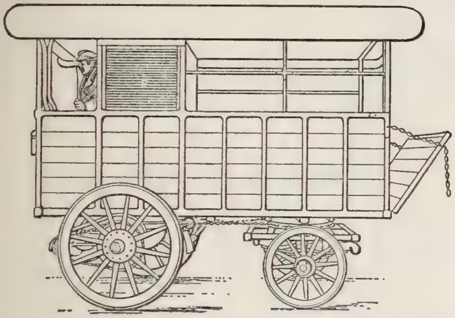
It cannot be said that any development can be particularly referred to in this carriage, its motor, or gearing, but great care has been bestowed on the design, construction, and workmanship in particular of all the details. The second and third prizes were also awarded to these makers for vehicles similarly operated, and the fourth and sixth prizes to M. Delahaye for vehicles similar to that, a view of which is now thrown upon the screen. This vehicle was exhibited in England last summer at the Crystal Palace Exhibition, and is one of those in which the motion is transmitted from the engine shaft by belting, the motor being, as most makers now prefer, of the horizontal type. It is one of those which received a diploma for gold medal at the Crystal Palace Exhibition. The carriage with which the fifth prize was won by MM. Peugeot et Cie, was similar to that described last year, and was driven by a modified Daimler type motor. The seventh and eighth prizes were won by the Maison Parisienne, or the Benz Company, of France, with vehicles fitted with the Benz horizontal petroleum spirit motor, the ignition of the charge in which is effected electrically. The ninth prize was won by a vehicle by MM. Landry and Beyroux with a cabriolet driven by a petroleum spirit horizontal motor. Both the tricycles which took prizes in the third class were of the Dion and Bouton type, as shown by the view now thrown upon the screen. The motor used in these tricycles is not fed directly with the petroleum spirit as in the case of the latest forms of Daimler motor, but receives a charge of carburetted air from a carburettor. Some most remarkable running was made by the Bollee motor tricycle, views of which are given.

Another carriage of which notice should be taken is that of M. Triouleyre, made by the Compagnie Generale des Automobiles, of Paris, which did some excellent running, and is operated by means of a horizontal benzoline motor, which drives a second motion shaft by means of leather belting, the driving wheels being actuated from this shaft by pitch chains. Two of these vehicles entered for the Paris-Marseilles race. A feature of M. Triouleyre's carriage is an arrangement of tubes and air blast for cooling the jacket water, the details of which are not, however, yet made public.

It is worth notice that M. Roger, the French Concessionaire of the Benz motor carriages, refused to enter the Paris-Marseilles trials because they were races, rather than tests of useful qualities.

The steam van illustrated in Fig. 1 has been made this year by the Thornycroft Steam Carriage and Van Company, Chiswick. It was one of those exhibited at the Crystal Palace Exhibition. It is a light van designed to carry one ton, with floor space available for goods of 25 square feet.

FIG 1.

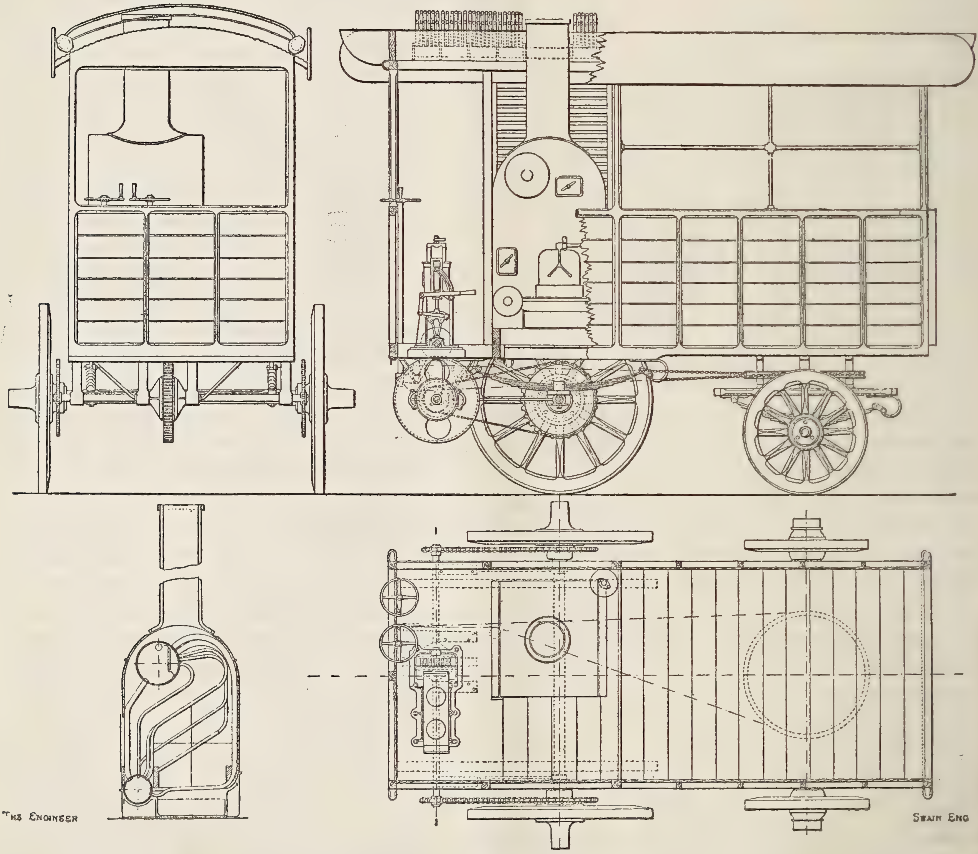


THORNYCROFT STEAM VAN.

Its length over all is 11 ft., of which 4 ft. 6 in. are devoted to the boiler and machinery. It is fitted with a Thornycroft water-tube launch boiler, having 50 square feet of heating surface and 2½ square feet of grate, and water-tube fire-bars, as shown in the engraving. The engine is a little double compound, having cylinders 2 in. and 4 in. by 3 in. stroke, and arranged so that the steam can be admitted to the low-pressure cylinders direct for steep hill climbing. The engine is geared to the driving-wheels at the ratio of 9 to 1. The fuel used is mixed coal and coke, about 4 lbs. per average mile being consumed. A skew-toothed pinion of large size gears into the corresponding teeth of the rim of the wheel carrying the compensating gear, this wheel being carried by the two inner ends of the second motion shafts, which at their outer ends carry the chain pinions by which motion is communicated to the driving-wheels. An air condenser is fitted on the roof of the van, which is capable of condensing all the steam at ordinary rates of working, and weighs less than 2 cwt. Its construction will be gathered from the end and side elevation, and it contains about 130 ft. of surface, the tubes being of thin copper half inch diameter, connected in groups to short lengths of 1¾ in. tubes held together by long bolts. The van complete weighs unladen about 30 cwt., of which 22 cwt. is on the driving wheel.

The general arrangement of the van and its machinery is well shown in Fig. 2. The bearings which carry the intermediate shaft are connected by radius bars to the main axle, to preserve the proper distance between the two sets of chain wheels, and have free play of the springs by which the van is carried. The chain wheels are fixed to the back of the driving wheel naves. The steering is effected by a hand-wheel on a verticle spindle, at the lower end of which is a worm gearing into a wheel of about 8 in. diameter, cast with which is a wheel which carries an ordinary link chain. This chain is led to a horizontal steering wheel on the locking-shaft steering wheels at the rear end of the van. The chain on this wheel is capable of adjustment for taking up slack. The brake is also put on by means of a hand-wheel and vertical spindle next the steering wheel. The steam connections between the engine and boiler are not shown in the illustrations, but they are of simple kind, a stop valve being within easy reach of the driver, who can also reach the link motion lever. The van was shown running in the Crystal Palace grounds, over roads which are in some places small loose gravel, which is trying, especially for iron-tyred driving wheels. The van runs very satisfactorily and smoothly, and will meet the requirements of a great many who, as carriers, are now waiting for such a vehicle. Some slight improvements in the steering arrangements might be made, and, if possible, the number of handles to be used should be lessened, and the exhaust should be capable of diversion into the chimney for hill climbing. All these are more or less easy of achievement, and the van meets the requirements of the Local Government Board under the new Act. The van recently ran from Chiswick to Windsor Castle, a distance of 20 miles by road, carrying over ½ ton of load in 2¾ hours, with 90 lbs. of coal and coke mixed in equal bulk, the run to Chiswick and back being made without any stoppage for adjustment or other purposes, and the Castle Hill was climbed without difficulty. This steam van may be taken as representing a class for which it may be expected considerable demand will arise, namely, a van to carry a ton and upwards of goods. The example shown is of the smaller size of a type which, running at a maximum speed of about eight miles an hour, would perform the work of country carriers and numerous classes of traders. In these the small extra weight of parts not admissible in the light passenger vehicles hitherto referred to, is a matter of smaller importance, and the maximum speed being low, they may be worked and steered with safety and certainty. The heavier class of vehicle, to carry and haul from three to seven, or more, tons, have yet to be made; and while for the light, quick passenger vehicles the experience and practice of the carriage and the cycle makers will be invaluable, it is the experience of the light road locomotive and traction-engine builders which will be drawn upon to make a success of the heavy motor vehicles. The author was recently called upon to express his views on motor vehicles for the heavy traffic of the Liverpool traders, and surprise was shown when he stated that although for those who really required them, light vehicles of a useful character could be had at the present time, those suitable for heavy traffic had yet to be made. For this reason he advised those whose expectations had been unduly raised with regard to such vehicles, not to be in a hurry to part with their horses. This view he still holds; but the realisation of the requirements of merchants of places like Liverpool, or of some of them, is perhaps within a measurable distance. The problem to be solved is, however, anything but an easy one, and if it is to be solved by means of the steam-engine, it would appear that very high pressures, high-speed engines, and high-class light boilers will have to be employed, rather than the very heavy boilers and comparatively low-speed engines at present used for light road locomotives. The development of the oil-engine is, however, sufficiently rapid to lead to the belief that this form of motor will ultimately take the place of the steam-engine for this class of work. Some indications of this are already afforded by the efforts of Messrs. Hornsby and Sons. Much attention has yet, however, to be paid to the trans-

FIG. 2.



THORNYCROFT STEAM VAN.—PLAN AND SECTION.

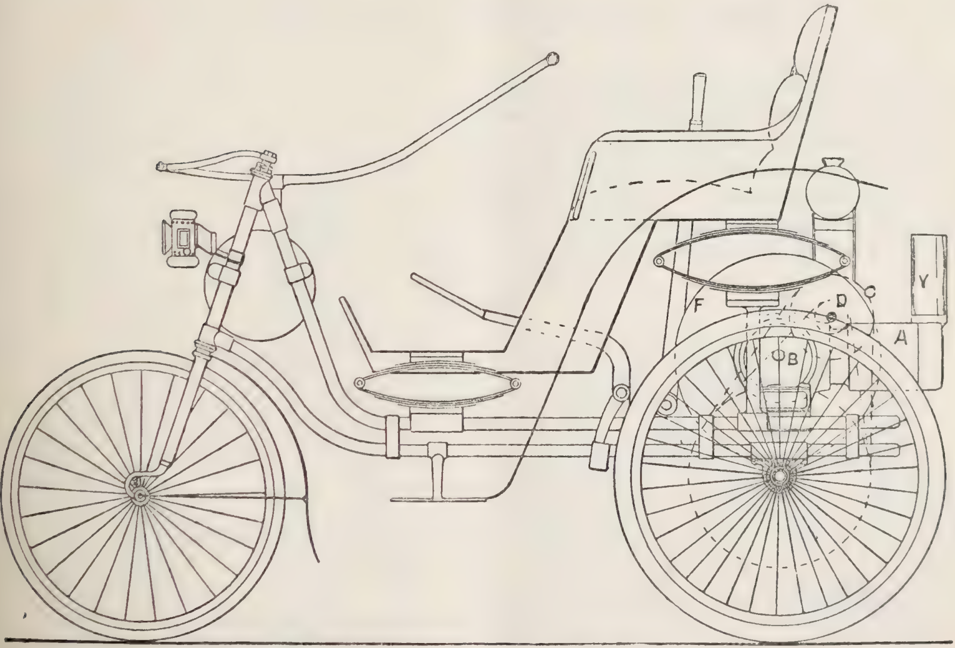
mission and stopping and starting gear to be employed.

The Duryea carriage, to which reference has already been made as being one of those present at the opening run from London to Brighton, contains several features of interest, one of which is that the motor has an oscillating cylinder; that it is supplied with gases the product of explosion of carburetted air under pressure from a separate explosion chamber. A lamp is used to effect evaporation, an electric arrangement being used for ignition of the charge. The motor transmits motion to a second shaft by means of belts for three speeds, and a cross-belt is used to obtain reverse motion at another speed. Jockey pulleys are used for giving either the one or the other of the belts sufficient tightness to enable it to drive. Spur pinions on the end of the second motion shaft convey motion direct to a hollow axle surrounding the driving axle, and carrying a compensating gear in the centre. Since this carriage and motor were made, Mr. Duryea has made great improvements.

The carriage, of which a view is now shown (Figs. 3 and 4), is one which has been built by Messrs. Roots and Venables, and is fitted with a motor which works with the ordinary lamp petroleum. The arrangements are in several ways novel and interesting, and it is one of the first finished carriages yet constructed to use the heavy oils of high flashing point. The motor works on the Otto cycle, and the rotating valve shaft, which must run at half the speed of the crank shaft, is utilised as a means of obtaining the first speed reduction. This is a very considerable gain, and allows of convenient arrangement.

In Fig. 3, A is the motor cylinder, B, the crank shaft geared to the wheel, E′, by means of a Reinhold chain, this wheel being on the rotating valve shaft, H, which is made large enough to transmit the power either by the chain on the small pinion, D, or the larger one, C, either of which are thrown into gear by means of a clutch at L. The oil supply is seen at O, and the vaporiser, on Roots system is at V. J, is the foot lever for a brake, and a vertical lever enables the driver to throw the motor in or out of gear, or to give the carriage one or other speed. The frame is formed of a double set of tubes which act as water coolers for the jacket water which circulates through them. (See Fig. 4, p. 26).

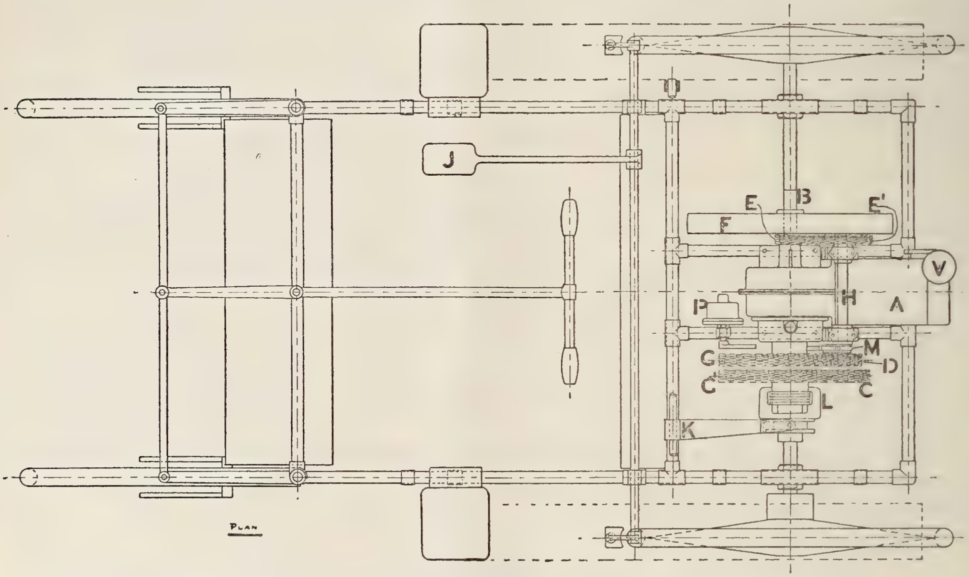
Fig. 3.



Roots' and Venables' Petroleum Oil Carriage.

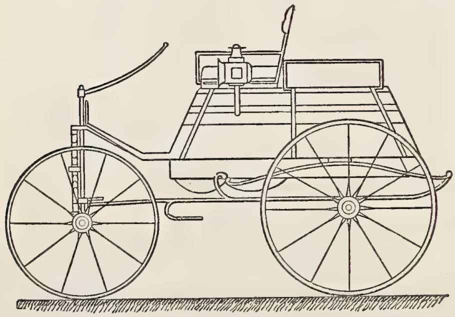
The carriage shown in Figs. 5, 6, 7, 8, is a petroleum motor carriage made by Messrs. Petter, Hill and Boll, of Yeovil, the motor being the design of Mr. Percival Petter, and the vaporisor used in connection with it is shown by Fig. 6 to be rudimentary only. Several carriages fitted with the arrangements of machinery shown in Figs. 5, 7, 8, have been made by this firm, and the author is informed that they are running with success. The motor is of the horizontal type, having two parallel cylinders, M M′, coupled to one crank shaft, N N′, upon which is a flywheel, W, and the pulleys, A, B and C, upon which are belts for driving either the high speed pulley, A′, or the low speed pulley, B′, or the reversing pulley, C″, through the medium of the rider pulley, C′, the three pulleys A′, B′, and C′ are fixed upon the second motion shaft, H, in the centre of which is the usual compensating gear, G, and on the ends of which are the two chain pinions, J J′, communicating motion to the driving wheels by means of pitch chains running on the wheels, K′ K′. From the sectional elevation it will be seen that by means of the handle, E, at the right hand of the driver, the belts connecting the pulleys, A A′, or B and B′, are thrown alternately into gear by pressing either the jockey pulley D or D′ upon

Fig. 4.



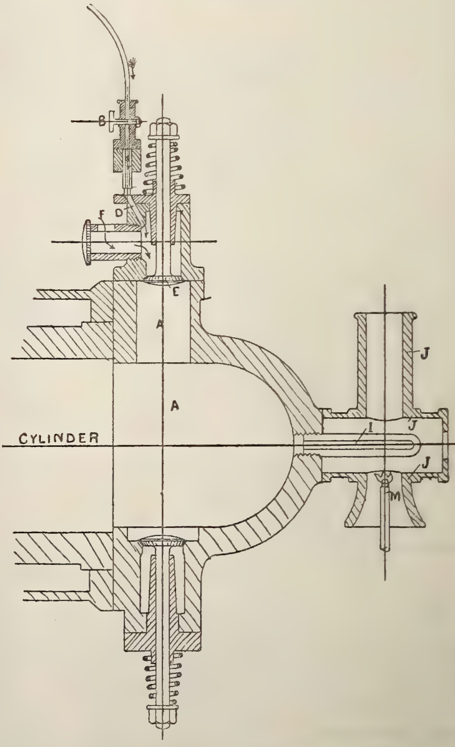
Roots' and Venables' Petroleum Oil Carriage.—Plan.

Fig. 5.



Petroleum Motor Carriage by Messrs. Petter, Hill, and Boll.

Fig. 6.

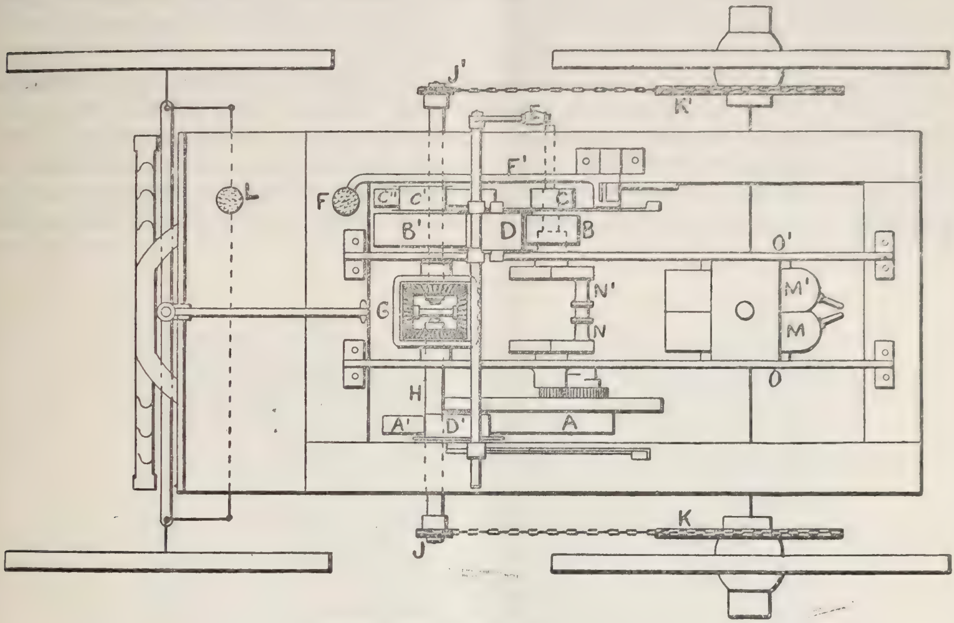


Petter's Oil Motor Cylinder and Valves.

those belts. As shown in the engraving with the handle E in the position 3, the jockey pulley D is tightening the belt on the pulleys B B′, for driving the carriage at the slow speed.

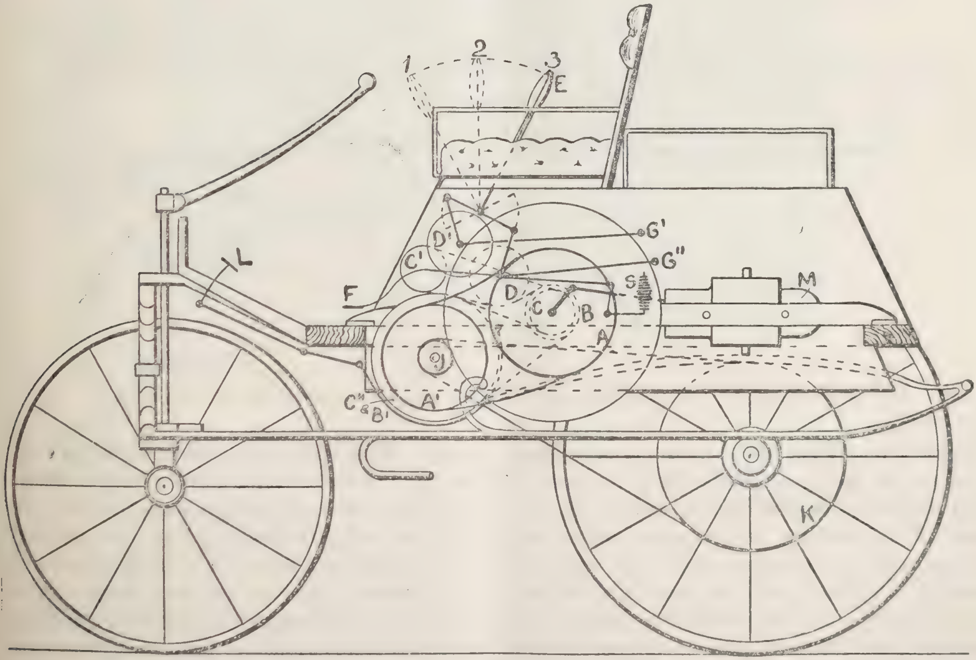
When the handle, E, is placed in the position 2, both sets of pulleys are out of gear and the belts free to slip; but when the handle is in the position 1, the jockey pulley, D′, comes

FIG. 7.



PETTER, HILL, AND BOLL.—PLAN.

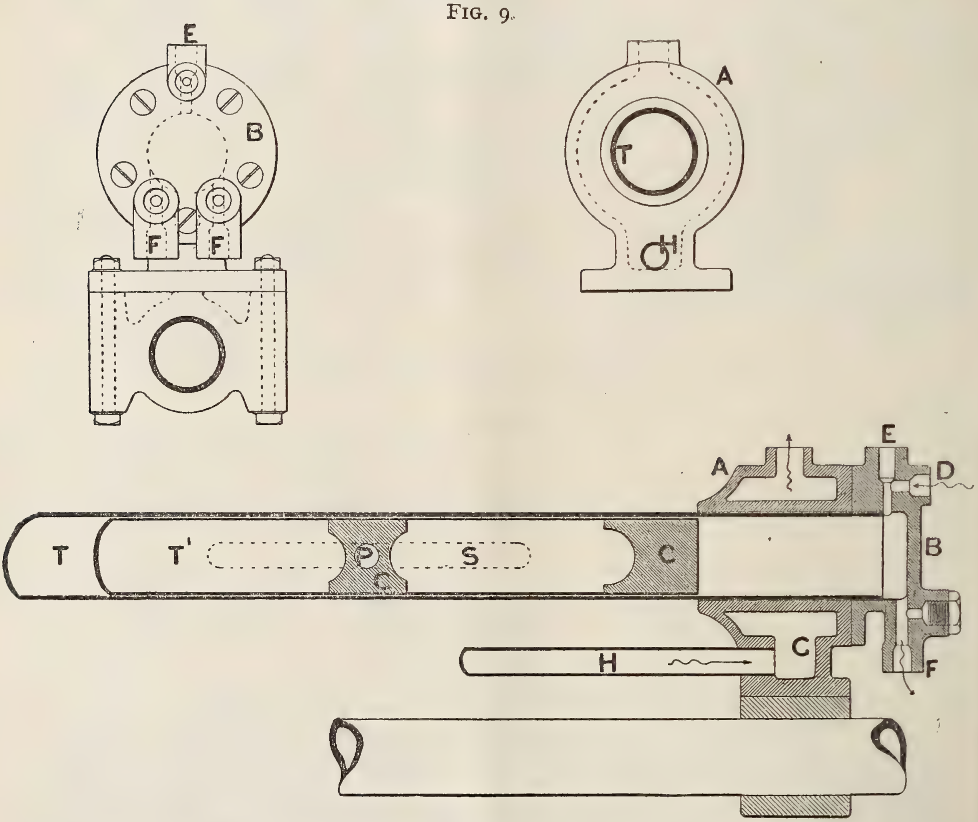
FIG. 8.



PETTER, HILL, AND BOLL.—SECTIONAL ELEVATION.

into play, and the belt connecting the pulleys, A and A′, is tightened upon them for driving at high speed. The handle, E, is on a shaft, F (Fig. 8), which carries levers from which depend links having on their ends the stud spindles of the jockey pulleys, D D′, which are controlled in their movements by the radius rods, G′ G″. An ingeniously simple reversing motion is obtained by means of the belt connecting a pulley, C, and pulley C′, the latter being carried upon a stud spindle held by the arm, F′, and under control of the foot by means of the pedal, I. When not in action, a spring at S keeps the pulley, C′, and the belt upon it from contact with the driving pulley, C″, but when it is desired to bring the reversing motion into gear, pressure upon the pedal, I, brings the pulley C′, with the lower part of the belt running over it intervening, upon the pulley C″, and thus a slow movement in the reverse direction to that given by the other pulleys is obtained. The pulley, C″, acts also as the brake pulley, by means of a band brake embracing about half its circumference, and brought into play by means of the pedal, L. In Fig. A is the compression space and combustion chamber, B, oil inlet cock, D, inlet passage to valve space, F, air inlet to valve, E and J, ignition tube heated by burner, M.

Fig. 9.

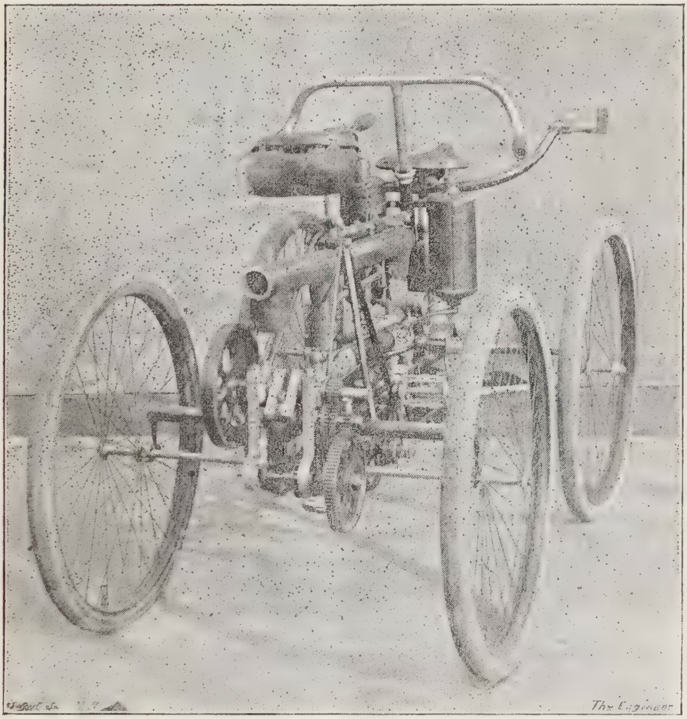


Crastin's Motor Quadricycle.—One End of Motor Cylinder and Piston.

The three views which will next be shown illustrate a motor quadricycle made by Mr. P. Crastin, Holloway, and operated by an oil motor using ordinary lamp petroleum. In the motor employed there are some details of interest, and though not at liberty to describe all these, some views and details are now given. From the general views it will be seen that the quadricycle with two seats is driven by a motor through the hind axle, and the first speed reduction is obtained from the rotating valve-driving spindle which, as in other Otto cycle motors, runs at half the speed of the crankshaft. By means of the remaining gear which is clearly seen, the speed of the motor, which runs at about 580 revolutions per minute, is reduced to the 130 revolutions per minute for a speed of 12 miles per hour. of the driving wheels, which are 2 ft. 6 in. in diameter.

The motor itself is double acting, that is to say, it has a double-ended cylinder in which the explosive impulse takes place alternately, so that one impulse is given for each revolution. A sketch diagram of one end of this cylinder is shown in Fig. 9. A shows the casting carrying the water jacket and the internal steel tube, T, which is fixed within it and protrudes into the cover, B. Within the steel tube, T, which has a slot, S, in the middle of its length for the accommodation of the crosshead pin, P, is a second tube, T′, carrying at the centre of its length the crosshead, C, and at each end the piston block, C′. In the lower part of the cylinder casting is fixed the tube, H, which provides for the circulation of the water through the jacket, G, from which it passes by a pipe at the cylinder top.

FIG. 10.

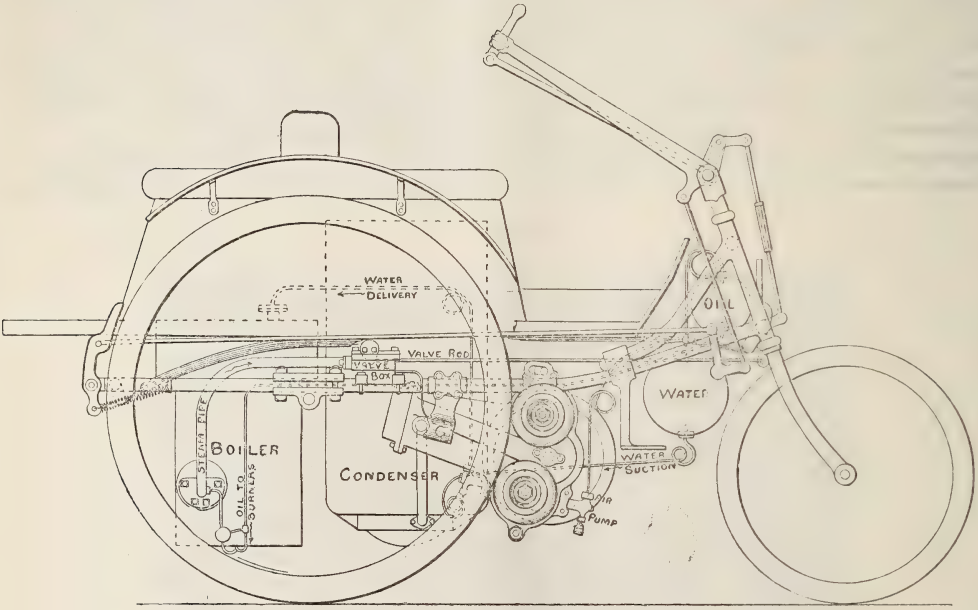


CRASTIN'S QUADRICYCLE.—END VIEW, VAPORISER AND CASING REMOVED.

The cylinder is fixed to the frame of the quadricycle by the clamp piece shown. Air and vapour enter the cylinder cover through a valve at D, and an ignition tube is placed at E; exhaust valves are fitted at F. The vaporiser employed is shown in a case at the back of the vehicle, and it consists of a small annular vertical vessel formed by an inner and an outer steel tube closed at both ends, the inner tube forming the chimney for a small vaporiser lamp. At the lower part of the annular space a tube is inserted, into which oil, from a form of sight feed lubricator, drops, and is drawn into the vaporiser when a suction charge is made, but passes away into an overflow tank when a charge is not required. The double-ended piston of this motor is 1·75 inches in diameter, and has a stroke of 4 inches.

The views now shown (Fig. 11 to 13) illustrate a steam carriage under construction, largely from the designs of Mr. H. Percy Holt, and although not yet completed, a description of it will be of some interest as being, as far as the author knows, one of the very few attempts to produce a steam carriage of considerable power and of light weight to carry four persons. From the three views it will be seen that there are two small steam-engines carried in two cases completely enclosing them, and driving by gearing also enclosed a pair of grooved driving pulleys acting directly on the peripheries of the pneumatic tyres to the driving wheels. The cases containing the engines are so mounted that when steam is turned on to set the carriage in motion, the grooved pulleys are automatically brought into contact with the driving wheels. The boiler is of a novel type but will not now be described. From the engines, either or both of which may be used, the exhaust steam passes into a condenser which is an air condenser acting partly on the principle of an evaporate condenser the exhaust steam itself actuating a fan which assists in the action of the air-cooling current. As far as is possible the control of all the parts has been made automatic, dependent only on the action of the steering handle influenced as far as more or less steam, *i.e.*, more or less speed, and as to the quantity of steam gener-

Fig. 11.



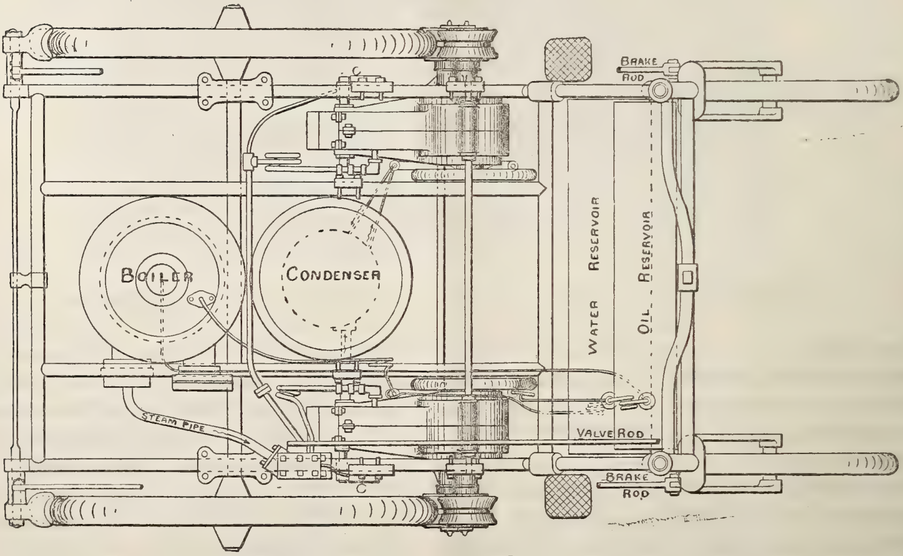


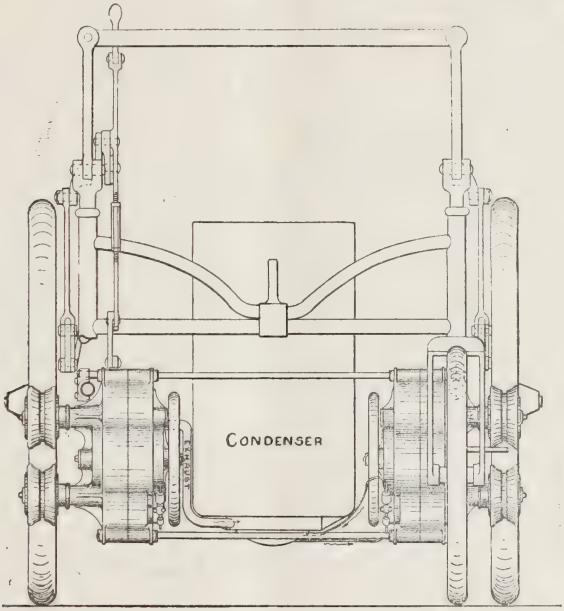
Fig. 12.—Holt's Steam Carriage.

ated, and as to the amount of fuel used, and the application of the brake, all as far as possible controlled by a movement simulating the action of the driver of a horse who gives more or less rein to his horse for more or less speed, or pulls very hard on them if he wishes the horse to understand that he is direly in need of all his help for a sudden stop. When the carriage shown is standing the brake actuated by the steering levers is in action. When the driver is in his place the steering levers, with a sleeve on the rod connecting them, are raised more or less, and this admits by the lever connections, shown in rather exaggerated dimensions, steam to one or by further movement steam to both of the engines. When running on a level and good road steam is only admitted to one engine but when gradients require it, it is automatically admitted to both engines by a movement corresponding to the loosening of the reins. When steam is shut off from the engines for stopping or for running downhill, a simple form of regulator cuts off the oil supply to the greater part of the oil burners by which the boiler is heated, the other burners being so situated that they are automatically relighted when steam is turned on by those which are not extinguished when steam is turned off.

There are many makers in this country busy on the construction or the design of motor carriages, but few of them are at present prepared to show what they have done. Some, including the makers of the Pennington motor cycles and bicycles, are so well known as to need no reference here.

There are several questions which arise in connection with the subject of this paper to which reference must be made. One of these is the speed question, because with it is involved that of power. For the present, at least, it must be conceded that the maximum speed for which motors and gearing for any motor carriages should be designed ought not to exceed the reasonable twelve miles an hour permitted by the Local Government Board regulations. This should not only be admitted on the grounds of public safety, but because of the lesser power which such a speed, as a maximum requires, as compared with the speeds which are being attempted, but because of the smaller weight of the necessary motor. It may be further urged that all the purposes of the greater number of users of these vehicles will be best served by the power which is sufficient for this speed as a maximum on good roads, and a correspondingly lower speed on any ordinarily steep gradients which can be surmounted by the same power. There is nothing fine or particularly laudable

FIG. 12.



HOLT'S STEAM CARRIAGE.—FRONT VIEW.

in rushing up steep hills at high speed, any more than there is in doing so with horses, while there is, on the other hand, very considerable possible gain by adopting the slow speed for hills, which also secures greater power for starting and working over bits of bad road. This consideration shows that for most vehicles, and particularly for trading vehicles, even when driven by steam, an effective arrangement of speed gearing which can with smoothness be put into or out of gear, so as to provide high-power by slow speed for starting and hill climbing, is necessary. In this way the small boiler power sufficient for maximum speed on good roads will be sufficient for bad roads and hills.

The diagram shown on the screen gives the power required for different speeds on different gradients for a vehicle and load of 2½ tons, and shows how very much the power increases with the higher speeds.

The limit to speed for lighter vehicles is possibly a very high one, but for vehicles for the average user it must be determined by some reference to economic running, to cost of the vehicle, and to the average conditions imposed by the observance of legal restrictions, and ordinary traffic convenience. In towns the limit and the maximum power required are in most places soon reached.

With regard to the use of petroleum or petroleum spirit motors, the recent alteration of the conditions under which the latter may be used in this country has removed the necessity, from a legal point of view, for adhering to the use of oils having a flashing point of above 73 deg. There is no doubt that there are good reasons for wishing that the oils of high specific gravity should be used, bnt it must be admitted on the other hand that the employment of benzoline has been singularly free, both on the Continent and in America, from mishap in connection with motor carriages. Some English firms, as already mentioned, have succeeded in making motor carriages propelled by motors which will use ordinary petroleum lamp oil, and having done so much, there are reasons for expecting that development in this direction may take place.

It cannot, however, be denied that the advantages from the point of view of simplicity of the motor attending the ready vaporisation of the lighter oil in the motor admission valves and passages, and ignition in the cylinder, are very great indeed, and that the objectionable smell of the exhaust gases is very much less than from the heavier oil. The great variation in the power required from the motor of a mechanical carriage, namely, as between the maximum power for climbing a stiff hill and the no power required when descending hills, introduces variations as to vaporisation, quantity of oil to be dealt with, temperature of cylinder, and ignition, which, as far as at present can be seen, must occasionally cause the ejection of much partially burnt oil with the exhaust, a difficulty which is much lessened by the use of petroleum spirit. The advances which have been made in the last year in the construction of oil or spirit-motors are not of a striking order, and the best known and most used of all is the Daimler of the improved form described by the author in the Cantor lectures last December. The float-feed regulator of this is used by M. Bollee in his tandem tricycle, which has done such remarkable running, and the new horizonal motor by M. Peugeot is made on lines similar to the Daimler. The feed apparatus cannot very well be conceived to be much simpler, and the automatic spray making preparatory to vapouring is so introduced that it adds nothing to the parts to be attended to. One at least of the makers seem to have courted disaster by using horizontal Otto cycle motors, the end of the cylinders of which were open for the reception of any dust and dirt that could find its way there, and several of the makers use horizontal motors of moderate speed, and consequently large diameter of cylinder, as the stroke is not long. There seems to be no doubt that in the future exceedingly good design, workmanship, and material must be combined, and very high speeds for motors be observed. This makes possible, not only small area of piston, but smaller impulse and less variation in the strength of the impulse. Some of the very small motors made by Mr. Pennington are said to be very good indications of the lines on which the motors for light vehicles will have to be made.

In the use of the heavier oils some advances have been made, but as the author has not actually tested any of the motors said to work satisfactorily without vaporisers, even of the simpler forms, he is unable to say more than that he is informed these motors do work with the heavier oils of specific gravity 0·8, and flashing point of over 73°.

In the construction of frames for motor carriages, the experience and inventions of the cycle manufacturer will be of very great help. Not only may the systems of building up be employed, but the tubular form may be usefully employed as storage or cooling surface for jacket water.

In some of the machines which took part in the Paris-Marseilles trials, it was found that under the excessively severe ordeal of a thousand miles race, often over excessively bad roads, the frames were severely tested, and brazed joints in several instances were found defective. On the other hand, mechanically connected frame members behaved well. When motor carriage construction has been sufficiently standardised, it will, no doubt, become common to connect members of the frames by castings and stampings, which are employed also as parts of the machinery.

The only novelty in the method of building up frames which has been announced is that of Mr. C. T. Crowden, according to which the tubes are slipped into their connecting collars or other parts, such as the cycle head and crank bracket, and then subjected to an internal water-pressure of about 2½ tons to the square inch. The inside of the sockets, of whatever form, are first grooved, so that under the water-pressure the thin tube is swelled into the grooves. The sockets and tubes are for the purpose of the process, placed within strong, well-fitting, cast-iron clamped dies, or moulds, so that the water-pressure does not burst either the thin pipe or the sockets. Some samples of frame-joints made this way are here upon the table.

There seems to be great probability that the light aluminium alloys having a specific gravity of from 2·9 to 2·95 will be found well suited for making the castings for the frame and machinery connections, because excellent castings of any form can now be made with these alloys, and the strength for a given weight is not only ample for every purpose when the thickness is enough to secure stiffness, but it is considerably stronger than steel, weight for weight. Steel castings cannot be made very light, and when necessary stiffness is taken into consideration, an aluminium alloy of specific gravity 2·95, and tensile strength of from 12·5 to 15 tons per square inch offer very considerable advantages, especially as such alloys work well in the machine shop and with the fitter. It must not be used where temperatures above about 200° Fahr. are likely to be frequent, and its extensibility being very small, it must not be employed where bending is required or likely to occur.

With regard to the tyres of wheels for light carriages and the lighter omnibuses and vans, experience to the present time seems to confirm the opinion of those who strongly favour the use of indiarubber, and particularly of pneumatic tyres. Experience and invention are no doubt developing the air tyre, so that its advantages will ere long far outweigh the disadvantage of its high cost. Very high speeds are however, especially with any considerable weight, very destructive both of solid and of pneumatic tyres. For the heavier vehicles now permitted under the recent Act and regulations there seems little doubt that wheels fitted with renewable wood treads may be very favourably mentioned, and it may be hoped that the Local Government Board Rules will in this respect, and in one or two other structural points, be modified in accordance with the experience which will soon, it may be expected, make modification necessary.

With a consideration of the kind of tyres most suitable for motor vehicles, arises the subject of road improvement, and the opinion may be confidently expressed that if mechanical transport on the high roads is to acquire the importance and the universality that its promised advantages make desirable, more attention than ever will have to be paid to the construction and maintenance of roads, and more money than ever will be profitably employed on this work.

Thus far no reference has been made to the development of electrically operated motor vehicles. This is because the development resolves itself almost entirely into a question of secondary battery construction. There can be no doubt that the electrical motor is, at present, the only one which offers a complete equivalent of the steam-engine with regard to range of power within the maximum, facility of starting and stopping, easy working, and freedom from vibration. It must, however, be left to those who have had recent personal experience in the use of secondary batteries for this purpose to state what the recent developments actually are, for the author's own experience in their construction cannot be quoted in connection with recent developments.

During the coming year great activity may be expected in connection with mechanical road carriages. British engineers are busy, and the prizes offered by the proprietors of the *Engineer*, to the value of 1,100 guineas, will, it may be expected, bring forward a great many vehicles, which will take part in the competitive trials to be held at the end of May, or beginning of June next. The conditions of this competition were published in the *Engineer* of the 20th of this month.

DISCUSSION.

The CHAIRMAN said this subject was now occupying public attention a good deal. It interested engineers at very nearly the beginning of the century, but now the public had got hold of it, and probably there would be the usual story—a good many failures, a good many accidents, a great deal of dissatisfaction, and then it would fall into disrepute. After the pendulum had swung in that direction, it would probably come back, and after a time the matter would be taken up in a proper and true spirit—that of engineering, not of company promoting. When that point was reached, it would be found that this mode of locomotion was really very valuable. He had so often spoken of his own experience, which went back, he was sorry to say, for 60 years, that he hardly liked to repeat it, beyond saying that, according to his judgment, nothing had been done recently which surpassed what was done then. There had certainly been a change from steam to oil motors, but he was glad to see that the reader of the paper appeared to be of opinion that the last word had not yet been said with regard to steam. Mr. Thornycroft's steam van, and Mr. Holt's steam carriage were illustrations. He did not consider that the flashing of water into steam was a very nice way of doing the work. It did not follow because you used water that you need carry several hundredweight of it; and, he might remark, that whether it were in a boiler or in a tank it weighed exactly the same. It was only the initial low-water level in the boiler which was extra, and the boiler need not be very heavy. With regard to reversing gear, Mr. Hancock, who was most successful in the use of road locomotion 60 years ago, told him that he never would allow his carriage to be reversed in London by the driver. The driver would only get into a fluster and back into something, and they would have the pole of an omnibus going through the casing of the boiler, or something of the sort. All he allowed the driver to do was to steer, or put on the brake with his foot, or stop, and that was found quite sufficient. If the Serpollet system used coke, he did not understand how the fire was damped down, or how they avoided getting too high a temperature when standing. He could understand that with petroleum it would be easy to prevent that taking place. Many present were probably aware of the arrangement of Mr. Howard, of the King and Queen Iron Works, many years ago, in which the boilers had no water in them, but just enough was injected to make one stroke of the engine, and that was repeated. There the reservoir to take up the heat of the fire was an amalgam of lead and mercury, and the water was injected on to a plate covered by this amalgam, the plate being indented so as to give more surface. There was another boiler, called the Parks boiler, very much like it. This system was used on a steamboat which ran from London to Ramsgate during the whole of one season; it was applied to a ship of war, and for years it drove the engines for the rolling mill at the King and Queen Iron Works at Rotherhithe. He did not know what objection there was to coke as a fuel when properly burned. All fuel must give off carbonic acid if burned properly, or carbonic oxide if burned imperfectly, and he did not know that coke gave off anything else. They all knew the difficulties with coal, but he could not speak from experience as to the lighter oils. When he was putting up an engine for an electric plant in a house he had in the country, he was deterred from using an oil-engine by an epigram. A friend said to him, "Do not use that thing; it will stink like a cat, and bark like a dog." Not liking that prospect, he put up an ordinary steam-engine. He did not gather how the draught was obtained in cases where a fire was used; as a rule it appeared to be produced merely by the ignition of the vapour in the cylinder; nor did he gather how the noise of the exhaust was got rid of. Some years ago he was much interested in an endeavour to introduce in London tramcars worked by compressed air, as they had been worked now for 15 years in France. They had to get rid of the noise of the exhaust air, and after trying many costly things, he at last thought of something very simple. He took an old hamper, doubled it up, and broke it, and put it in a case, and then turned the exhaust air into that, and the twigs of the hamper so bothered the compressed air, that they never heard any more of the noise. A similar kind of device was used with gas-engines. He did not quite understand one of the boilers which had been described as having a high water pressure, and low steam pressure. Perhaps Mr. Beaumont would explain it.

Mr. BEAUMONT said there was a reducing valve between two parts of the boiler. The part containing the water was constructed of tubes, and the water in those tubes was carried very much in the same way as it was in the Perkins hot-water heating apparatus, from that the water was taken through a reducing valve, and converted into steam.

The CHAIRMAN said he was surprised to hear that pneumatic tyres would stand the wear incident to traction wheels. He remembered Mr. Hancock telling him that he had much less trouble with the wear of his engines and boilers than with the wear of his tyres. If pneumatic tyres by reason of their pneumaticity (so to say) were capable of getting over that trouble, it would be a very important matter. He often thought that if he were a man of wealth and leisure, he should like to make a servile copy of one of Hancock's steam omnibuses, and put it to work, as the original did, between Paddington and the Bank, and then ask the present generation of engineers to try and improve upon it.

Mr. WALTER HANCOCK said no one was more surprised and delighted that so much had been done with petroleum motors, but at the same time the advantages of steam were so thoroughly worked into his whole thoughts, that he could not but think that there was a good deal to be done yet by the steam-engine, when the attention of the engineers of the present day was directed to the problem of road locomotion. Going back to the time when his uncle first worked at steam carriages, and comparing the steam-engine of those days with those of the present—considering the form of the slide-valve, which then had none of the advantages of lap and lead—which had produced such an economy in working, and thinking also of the change introduced by the link gear by which the expansion was now controlled, and, therefore, the consumption of steam according to the varying load, it might be safely said that the little van described by the author was one which pointed very strongly to the advantage to be gained by the use of steam. The engines in that van were little more than toys: the cylinders were only 2 in. and 4 in., in fact, he thought it carried economy of engine power to exception. If the cylinders had been 2½ in. by 5 in. he thought it would have been a most economical machine for traction on roads. As it was, it would carry something like a not. He hoped the engineers of to-day would devote their skill and energy to this question, and adopt all the improvements of the modern steam-engine to road motors, and then he believed steam would hold its own for both economy and comfort.

Mr. A. R. SENNETT, referring to the Chairman's remark that he regretted that his experience went back sixty years, said he was inclined to think that he would rather have lived sixty years ago, for that was evidently an engineering epoch. Then a man who wanted a machine went to an engineer, whereas now he went to a company promoter. He had had some experience of the Serpollet boiler, and that afternoon had run some thirty miles with a carriage constructed by that inventor. With regard to the damping down of the fires where coke was used, there was no precaution taken, except that the ashpit door was opened towards the front of the carriage only. The blast up through the bars due to the motion of the carriage was all that was required. He had slightly altered M. Serpollet's arrangement by putting a hopper in front at an angle of 30° from the horizontal downwards; if anything, that acted rather too well, and all that afternoon they had rather too much steam. It now only required to be fitted with a butterfly valve damper to be under perfect control. He understood the author to intimate that the reserve of therma energy in the Serpollet tubes was a matter of seconds—that it was soon exhausted. He would wish to emphasise the fact that the draught upon this reserve was made concurrently with the normal steaming of the boiler. It was far more than a matter of seconds, and its utility was of the greatest importance. That afternoon he drove from Worthing to Horsham—not the most level of roads—but though the carriage was provided with a hill-climbing speed and a high speed, they never put on the hill-climbing speed the whole time, and never saw any visible steam, even on the longest hill. His experience was that by putting on the slow speed you made such a vast number more revolutions in climbing a hill, and before you got to the top of it, if it took more than (say) ten minutes, the superheating became ineffective, and you got visible steam, which was forbidden by the Act. It was curious in what a slipshod way the French carriages were put together; the syphon tubes outside the boiler were not protected in any way, and while the boiler tubes were at such a high temperature, immediately outside there was a rush of cold air. The same with the cylinders; they were not lagged in any way, and were placed in such a position as to catch all the grit and dirt. It was really wonderful how well the carriages behaved, built in the way they were. Of course, Serpollet was not the first to invent a flashing boiler, nor even to apply it to a carriage, and he was inclined to think that the Serpollet system was really an English invention. It was Jacob Perkins who taught them to use a flashing boiler, and Mr. Loftus Perkins, who did so much in high pressure steam, built a little tractor, much smaller than any that Dion and Bouton's built in Paris to-day. It ran about London for some time, but being exiled by Act of Parliament, went to Brussels, where it ran a considerable time; then the boiler was taken out and copied and put into tram-cars, and now the same system was carried out by M. Serpollet in a manner which did him great credit.

The CHAIRMAN said according to his recollection the Perkins carriage, on which he had ridden, had a a boiler containing water at high pressure—not a flashing boiler.

Mr. SENNETT said he believed it was a flashing boiler. It was a tractor with only one wheel which was attached to a four-wheel van. The single driving wheel was covered with indiarubber. As the Chairman had said, a flashing boiler did not reduce the weight; it was heavier if anything, but the extra weight was more than compensated for by its safety and flexibility. The Dion and Bouton boiler required a very large area or a very high rate of combustion, as a means of raising steam rapidly for hill climbing, and it was a most dangerous boiler to place in the hands of unskilled drivers. With a tubular flashing boiler all danger was eliminated. If you had to stop suddenly an ordinary boiler went on making steam, and up went the safety valve and frightened the horses. With boilers of the Thornycroft or Yarrow type you had great power, but there ought to be some means of arresting the combustion or radiant heat when the carriage stopped. He should like to know how the oil-feed in the Serpollet carriage was regulated. In the historic Parkinson and Bateman tricycle there was a regulating arrangement similar to one recently introduced by Mr. Cross, consisting of a steam piston, held down by a strong spring, so that directly the steam rose above a certain pressure the spring compressed, and the different jets were automatically shut down. He found nothing at all objectionable in coke, which was a much cleaner fuel than petroleum. They never put any coke on the fire; it was put in a hopper, and the shaking of the carriage shook it down. That afternoon they had rather less than one sack of coke put into the hopper at Worthing, and as a precaution about one quarter of a sack more was put on the front of the carriage. They ran the 25 miles into Horsham with the use of about three parts of a sack. It was, of course, very unscientific to use petroleum or liquid fuel for a steam-engine, because a steam-engine was a heat engine of low efficiency, whereas an internal combustion engine was one of high efficiency; but, nevertheless, the ease of manipulation, the simplicity, and the much to be desired flexibility of power was so great in the case of steam, that now English engineers had a chance of working at it he thought they would put a different complexion on the matter. In reply to a question from Mr. Beaumont, he sàid he believed the carriage he had been describing weighed about 24 cwt., but he had not weighed it.

Mr. S. H. TERRY said he was very glad to hear from so high an authority as the Chairman that steam was not dead yet, and he gathered that Mr. Beaumont also thonght it had yet a future before it. He had brought with him some photographs, which perhaps might be thrown on the screen, of a once well known steam carriage, called the "Fly-by-Night," built some years ago by Messrs. Carrett and Marshall* for Sir Titus Salt, which afterwards became the property of Mr. Des Vigne, who was present, and, he hoped, would say something about it. It ran a great many thousand miles, but, unfortunately, owing to difficulties raised by the local authorities, its career came to an end.

The photographs having been shown,

Mr. DES VIGNE said the "Fly-by-Night" had many points of interest, even at the present day. When first constructed from the design of Mr. George Salt it was not by any means perfect. The steering gear was not first rate, and it did not go round corners well. It had, perhaps, the first example of the "Jack-in-the-Box," compensating gear of bevelled wheels and hollow shaft. Then they could not keep steam; and, after trying several sorts of feed water-heaters, they at last put some hanging tubes in the smoke box of a peculiar construction, by which they got the water into the boiler rather above boiling point, and that acted very well. There was also an expansion gear, which saved a lot of water, and seemed to do almost as well as a compound-engine. They could not use it except on a fairly level road, for when going up-hill, or over rough stones, the consumption of water went up rapidly. It weighed about 6 tons, and of course that wanted a lot of propelling; still they went up Chatham hill with it all right. Mr. Aveling, who was present, said it carried too much steam, and that the pressure (150 lbs.) was too high. However, when they had the expansion gear on, they put on another 30 lbs., and it stood it all right. When the Act was passed, the engine could no longer run; the engines were put into a steamboat, and the wheels were sold, but he still had some of the parts.

Mr. TERRY then showed a photograph of another steam-carriage now being constructed at Teddington, by Messrs. Des Vignes and Co., with vertical tube boilers, the engines being entirely self-lubricating. He did not think any passenger would know there was an engine on board, which was not a common feature in motors. He did not want to disparage oil motors, for he thought the builders of them had taught them all some useful lessons, one of the principal being that they must keep down the weight. The "Fly-by-Night" was very heavy, but the one of which he had shown the photograph was not so heavy as it looked. The points required were strength and rigidity, with great elasticity between the road and the passengers, and even the engines, for you did not want the engine to receive violent shocks from the road, so that he thought they must employ some form of indiarubber tyre.

The CHAIRMAN having proposed a vote of thanks to Mr. Beaumont, which was carried unanimously,

Mr. BEAUMONT, in reply, said the recent developments in these carriages were necessarily matters of detail, and those who were engaged in perfecting them were not disposed to say much about them. In many cases, although he knew what was going on, he was not at liberty to publish the information. The value of the Serpollet flashing boiler lay in the fact that it was constructed of tubes, which were perfectly happy whether they had water in them or not. They were of considerable thickness, and being surrounded by cast-iron, might remain safely exposed to the heat of the furnace, much of the heat being accumulated in the mass of metal. The advantage was that when steam was not required, it was not being made, and no risk was being run of a sudden pop of the safety valve. No doubt the tubes would gradually burn away, but that process would be very slow, and of little importance compared to the advantages secured, of generating steam only when required, and of having a boiler which anybody could use, and hardly know it was there. In reply to a question by the Chairman, he said he did not know what temperature the tubes reached, or whether the water in those very small tubes got at all into the spheroidal condition. The noise of the exhaust was prevented in some cases by passing it into the furnace and out with the products of combustion. Pneumatic tyres had been used for a long time for traction purposes, but not for the heavier work, and for that further experience was required. The Perkins tractor he had described in his lectures last December. It had a Perkins boiler—not a flashing boiler—and was a single-wheeled engine attached to a four-wheel van. The Dion boiler was open to the objection that there was a certain quantity of water on which the fire still acted when the carriage stopped, and, therefore, steam was still generated. No one had a higher appreciation of the work done by Hancock, not only as regards actual achievement, but as indicating what might be done at the present time, and he wished that work was more studied. In the *Times* of that day there was a paragraph calling attention to the successful working of a coach built by Ogle and Summers which ran from Oxford to Birmingham about 64 years ago. If they could do that with a steam-engine, and if Hancock did it continuously, as we know he did 60 years ago, surely those going into the question now would do well to study their work, and not throw away the advantage of the experience then gained. In those days the coaches or vehicles were much heavier than now, and the weight of the boiler and engine was, therefore, less in proportion to the total weight, than in the small light vehicles now aimed at, and of course this introduced new conditions which had to be met. Still there was too much inclination to go to work without taking account of former experience. The carriage described by Mr. De Vigne was really only an engine and boiler on wheels, with a seat or two put upon it. It would not do now to build a vehicle weighing 2½ tons to carry four people.

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* *See* Cantor Lectures by the Author.

Miscellaneous.

THE TURQUOISE MINES OF PERSIA.

The British Vice-Consul at Meshed says that the celebrated turquoise mines, near Nishapur, are believed to be the only mines in the world worth the name, which have been worked extensively, or which have produced the turquoise of perfect shape and colour. On approaching the turquoise mines from the direction of Nishapur, after entering low hills and gradually ascending, there are two villages inhabited by the miners, which are on undulating ground, about 5,000 feet above sea level. After another gradual ascent for about a mile by a very good road, the foot of a modest hill about 1,000 feet in height is reached. All the mines are on the south face of the hill, and from east to west, from the first to the last, the distance as the crow flies is not more than half-a-mile. But the hill consists of several ridges, separated by ravines, and to arrive at a mine within a stone's throw of another, may entail half-an-hour's journey up and down hill. Besides these underground mines, there are what are called *khaki* (earth) mines. There are three mines worked by lessees, but they are worked on a system bad in every way. At present, the superintendent employs only 100 miners at the three mines. These work in two reliefs, by night and by day. The Consul gives a description of a visit he made to these mines, and states that he first visited the Reish mine, which is the only one worked on a large scale, or with vigour, and which produces the greater part of the torquoises at present sent to market. It is near the top of one of the highest ridges, at an altitude of about 6,000 feet above sea level. The entrance of the mine is a hollowed-out cave, about twelve yards across, with a vertical shaft some five yards in diameter. At the time of his visit, two men were reclining at the mouth of this shaft with their backs against the wall of the cave, and turning with their bare feet a ricketty wooden wheel, which brought up the *débris* from below in a small sheepskin bag. This bag was received by a third man, who unhooked, emptied, and re-attached it. The other two men removed their feet, and the bag went down with a run some 40 feet, where three other men were similarly engaged on a ledge in the shaft. The mine itself is some 80 or 90 feet from the surface, but the descent was impracticable in boots. The miners first descend by means of a narrow diagonal tunnel, and then scramble down the rough sides of the shaft. At the mouth of the cave, which is on the precipitous hillside, half-a-dozen men were seated close together on a ledge, breaking with small hammers, the fragments of rock as they were brought up from below. When a turquoise was discovered, it was placed on one side in its rough state encased in rock. Although this mine is very productive, and the turquoises of good shape, their colour soon goes. From the Zaki and one or two other mines a few fair turquoises are obtained, and in the detritus on the hill and down near the village a good stone occasionally comes to light. The work in these khaki mines is easy and light, and generally undertaken by women, old men and children, who pay a kran each day for the privilege. All they have to do is to dig up 2 or 3 feet of the soft soil and to sift it. They find, perhaps, half-a-dozen turquoises in a day. Although really good turquoises are rare, an abundance of imperfect and bad stones are turned out, and are largely bought up, for all Orientals prize them, and the very poorest like to possess even a green and spotted one set in a tin ring. Notwithstanding the fact that good stones are rarely found at present, it is more than likely that the hill contains them in abundance. Only an infinitesimal portion of the south side of it has been opened, and yet almost wherever they dig the turquoise in some shape or other turns up. Even before the hill is reached the visitor sees the ground strewn with the mineral in every stage of composition. In one of the early stages it is a sort of cream-coloured chalk, which is said to have medicinal properties, and which the people eat with apparent zest. Then it is seen like hard chalk, and then embedded in the fragments of rock lying round, and of various shades of blue and green. Fragments of turquoise may be picked up at the mines, the size of a walnut, but of no value whatever, being full of flaws, and of a dirty light green colour. All the way up the hill the ground is littered with these fragments, and on entering the mouth of any of the large mines, the roof and walls appear to be seamed with the turquoise. Some of the stones now found look excellent at first, but the colour in most cases soon fades, or a green tinge is developed, or spots appear on them. Some of these white spots can only be detected at first with a glass, and then as a mere speck, but in time they may expand and spread right across the stone. The colour of most faded turquoises can be temporarily revived by dampness, and this should be borne in mind by all purchasers. The Vice-Consul says that at the mines he was offered a large number of turquoises of good colour, but in every case the vendor brought his stone in his mouth, and when he fancied himself unobserved, slipped it into his hand, and then promptly offered it for sale. In Meshed, no one would dream of buying a turquoise of good colour without possessing it first for some days. The turquoises, as soon as they are cut, are nearly all sold at once for export. Seven or eight years ago one could obtain in Meshed really good turquoises of perfect shape, good colour, fair size, and without a flaw, for a few shillings each, and that without trouble, while at present it is almost impossible to obtain such a stone at any price, and after weeks of searching. Turquoises are at the present time far cheaper at Tiflis and Constantinople than at Meshed, and even in India they are cheaper.

THE TEA TRADE IN RUSSIA.

Tea is the national drink *par excellence* in Russia; it is as indispensable in the food of the people as bread or meat, and is taken at all hours of the day. In every town tea-houses are found where a large glass of tea, with plenty of sugar in it, is provided at a cost of from three halfpence to twopence halfpenny, according to the town and the position of the customers frequenting these establishments. In these circumstances it is only natural that the consumption of tea in Russia attains enormous proportions, and is yearly on the increase. According to the *Journal de la Chambre de Commerce de Constantinople*, Russia imported in 1894, through the port of Odessa, 15,692,000 kilogrammes (kilogramme = 2,204 lbs.) of tea from China. Through the Custom-houses of the Baltic large quantities of tea are entered, chiefly consigned to Moscow, or for local consumption, and by the land customs of Eastern Siberia, about 20,000,000 kilogrammes of tea, representing a value of about 50,000,000 roubles, were imported. All the tea imported by way of Odessa or other European frontiers is leaf tea, but that coming into the country *viâ* the Chinese frontier is chiefly tea in bricks of different dimensions. These teas are consumed by the nomads and the northern peasants, by reason of their cheapness and the facilities of transport. The customs duties on this kind of tea are much lower than those on leaf tea. In the various retail shops leaf tea is sold in packets weighing $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, or 1 Russian pound at prices, varying according to quality, from 80 copecks to 5 paper roubles the pound, but as a rule sufficiently good tea may be purchased for 1 rouble 50 copecks to 2 roubles 50 copecks per pound. Russia exports annually a certain quantity of tea in packets, prepared by the large importing houses of Moscow, which are well-known throughout the whole of Europe. By way of Odessa, 30,000 kilogrammes were shipped in 1894 to the destination of Roumania, Bulgaria, Turkey, and Austria-Hungary. About two years ago tea from Ceylon began to be imported, but the quantity so far has been inconsiderable.

Obituary.

Sir Benjamin Ward Richardson, M.D., F.R.S.—By the death of Sir Benjamin Richardson on Saturday, 21st inst., the Society of Arts loses a prominent member, who took an active interest in its work, and was a frequent attendant at its meetings, as chairman, as reader of papers, and as lecturer. He was elected a member in 1877, was a Member of Council from 1878 to 1886, and a Vice-President from 1881 to 1885. He held the office of trustee of the Soane Museum, by election of the Society, from 1882 to the time of his death. He delivered a course of six Cantor lectures on "Alcohol: its Action and its Uses," in 1875, and a course of special lectures on "Unhealthy Trades" in 1875-76. Dr. Richardson was appointed by the Council to make special inquiry into this subject, and these lectures consisted of his reports. He delivered a lecture on "Vital Air" on March 21, 1877, and in 1878 six Cantor lectures on—"Some Original Researches on Putrefactive Changes, and on the Preservation of Animal Substances"—two lectures "On the Preservation of Animal Structures from Decomposition" in 1879, a lecture on "Fleuss's Diving Apparatus" on May 6, 1880, and another on April 28, 1882, on "National Necessities as the Bases of National Education." He read a paper on March 26, 1884, on "Vital Steps in Sanitary Progress," and delivered a lecture "On the Painless Extinction of Life in the Lower Animals" on December 18, 1884, and one on "Removal of House Refuse independent of Sewage" on April 15, 1885, and four Cantor lectures on "Animal Mechanics" in 1886. Sir Benjamin Richardson was born at Somerby, Leicestershire, in 1828, and took the degree of M.D. at the University of St. Andrew's in 1854. For a time he was in general practice at Barnes, but he soon settled in London as a consulting physician, and from this time forth his life was one of incessant professional and literary activity. He became a Member of the Royal College of Physicians by examination in 1856, and was elected a Fellow of the College in 1871. He conducted many researches on the administration of anæsthetics, on the action of poisons, on the restoration of life after various forms of apparent death, and on methods of killing animals without the infliction of pain; but his investigations were so many, and his works so voluminous, that they cannot be fully catalogued here. Special mention may, however, be made of his sketch of an imaginary model city of health, called "Hygeia," and of his life of and collected edition of the essays of the late Sir Edwin Chadwick. He edited the *Journal of Public Health* and the *Social Science Review*, and wrote the whole of a quarterly medical journal named the "Asclepial." He was elected a Fellow of the Royal Society in 1867, and delivered the Croonian lecture in 1873. He was knighted in 1893. In 1868 he was presented with a microscope by Ross and a purse of 1,000 guineas, as the result of a subscription among members of his own profession, "in recognition of his various contributions to science and medicine." His last appearance as chairman of a meeting of the Society of Arts was on March 20, 1895, when Mr. H. F. Lester read a paper on "The Progress of the Abbatoir System in England."

BRIGADE SURGEON LIEUT.-COL. JOHN BERRY WHITE.—Mr. Berry White, who died suddenly (aged 62) on the 19th inst., while presiding at a public meeting at Winchester House, was elected a member of the Society in 1887. On the 27th May, 1887, he read a paper before the Indian Section on "The Indian Tea Industry: its rise, progress during fifty years, and prospects considered from a commercial point of view;" and the chairman at the meeting (Sir Roper Lethbridge) spoke of him as "undoubtedly the first living authority" on the subject. Mr. White was a Brigade Surgeon of Bengal, but retired in 1882, and then devoted his attention to commercial pursuits. For many years he was in medical charge of one of the most important districts of Assam, and in that capacity he obtained a full knowledge of the cultivation of the tea plant.

General Notes.

ELECTRIC RAILWAYS IN EUROPE.—Vice Consul Monaghan of Chemnitz says that the number of electric railways, street and other, went up in Europe during 1895 from 70 to 111; length of lines from 700 kilometres to 902 kilometres (kilometre = ·621 of a mile); the number of carriages from 1,236 to 1,747. Germany with 406 kilometres heads the list, France comes next with 132 kilometres, England 94, Austria-Hungary 71, Switzerland 47, Italy 40, Spain 29, Belgium 25, Iceland 13, Russia 10, Servia 10, Norway and Sweden 7, Bosnia 5, Roumania 5, Holland 3, and Portugal 2.

INDUSTRIAL MUSEUM IN CHINA.—According to the *Journal des Tarifs et Traités de Commerce*, the Pekin University has recently installed in one of its halls a kind of industrial museum with the special object of making known in China, machinery and mechanical apparatus of foreign make. Besides the machinery in motion, the articles exhibited consist of models, plans, or photographs of various kinds of machinery, dynamos, locomotives, firearms, waggons, ships, windmills, looms, printing presses, &c. The museum in question, it appears, has been visited by a great number of people belonging to the well-to-do classes, and has become a very useful means of advertisement for American goods in China, as the Pekin University is established under the auspices of the American Episcopal Methodist Mission.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

DECEMBER 2.—"The Teaching of Economics." By W. A. S. HEWINS, M.A. SIR OWEN ROBERTS, M.A., D.C.L., will preside.

DECEMBER 9.—"Mining at Great Depths." By BENNETT H. BROUGH, Assoc.R.S.M.

DECEMBER 16.—"The Chamber Music of Purcell, Handel, and Bach." (With Illustrations on the original Instruments for which it was written.) By ARNOLD DOLMETSCH.

Papers for meetings after Christmas:—

"Children's Sight." By R. BRUDENELL CARTER, F.R.C.S.

"Light Railways." By EVERARD R. CALTHROP.

"Cycling—Historical and Practical." By GEORGE LACY HILLIER.

"A Half Century of Line Engraving, 1780-1830." By GEORGE CLULOW.

"Lithography as a Mode of Artistic Expression." By LEO MCCULLOCH.

"The Artistic Treatment of Heraldry." By W. H. ST. JOHN HOPE, M.A.

"Dairy Produce and Milk Supply." By M. J. DUNSTAN, M.A., F.R.S.E.

"The Transmission of Power by Alternating Electric Currents." By W. B. ESSON, M.Inst.C.E.

"London Water Supply." By PERCY F. FRANKLAND, Ph.D., F.R.S.

"The Chemistry of Tea." By DAVID CROLE.

"The Evolution of the Silver Question." By MORETON FREWEN.

"The Moral Advance of the Peoples of India during the Reign of Queen Victoria." By WILLIAM LEE-WARNER, M.A., C.S.I.

"A Visit to Russian Central Asia." By MICHAEL FRANCIS O'DWYER.

"Cultivation and Manufacture of Rhea Fibre." By THOMAS BARRACLOUGH.

"The Roller Boat of Mons. Bazim." By EMILE GAUTIER.

"Development of Ireland's Industrial Resources." By the HON. HORACE PLUNKETT, M.P. (Chairman of the Recess Committee).

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at Half-past Four o'clock :—

January 21, February 11, March 11, April 1, 29, May 20.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesdays, at Half-past Four o'clock :—

January 19, February 16, March 16, April 6, May 4, 25.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

January 26, February 9, March 2, 30, April 27, May 11.

CANTOR LECTURES.

The following course of Cantor lectures will be delivered on Monday Evenings, at Eight o'clock :—

PROF. VIVIAN B. LEWES, "The Use of Gas for Domestic Lighting." Three Lectures.

NOVEMBER 30.—LECTURE II.—Incandescent mantles and burners—The effect of globes in diffusing and absorbing light—Street lighting—Atmospheric influences and the penetration of light.

DECEMBER 7.—LECTURE III.—Gaseous illumination where coal-gas is not available—Oil-gas and its properties—Acetylene: its manufacture and use—Acetylene burners and generators—Railway and tramcar lighting.

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Thursday Evenings, at Eight o'clock :—

PROF. JAMES A. EWING, M.A., F.R.S., "The Mechanical Production of Cold." Six Lectures.

January 28, February 4, 11, 18, 25, March 4.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian B. Lewes, "The Use of Gas for Domestic Lighting." (Lecture II.)

Imperial Institute, South Kensington, S.W., 8½ p.m. Dr. G. H. Bryan, "Flight, Natural and Artificial"

British Architects, 9, Conduit-street, W., 8 p.m.

Actuaries, Staples-inn-hall, Holborn, E.C., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Rev. J. Courtney Gale, "To Lyonesse with a Camera."

London Institution, Finsbury-circus, E.C., 5 p.m. Dr. D. Morris, "Recent Researches in Commercial Fibres."

TUESDAY, DEC. 1...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Further Discussion on Dr. Percy F. Frankland's paper, "The Bacterial Purification of Water."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. Forsyth Major, "The General Results of his Zoological Expedition to Madagascar." 2. Mr. Stanley S. Flower, "Notes on a Collection of Reptiles and Batrachians made in the Malay Peninsula, with a List of the Species hitherto recorded from that Region." 3. Mr. G. A. Boulenger, "Description of New Fishes from the Upper Shiré River, British Central Africa, collected by Dr. Percy Rendall, and presented to the British Museum by Sir Harry H. Johnston, K.C.B."

WEDNESDAY, DEC. 2...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. A. S. Hewins, "The Teaching of Economics."

Geological, Burlington-house, W., 8½ p.m.

Entomological, 11, Chandos-street, W., 7 p.m.

Royal Society of Literature, 20, Hanover-square, W., 4½ p.m. Dr. Lentzner, "Style."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, DEC 3...Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. Rev. Geo. Henslow, "Does Natural Selection play any part in the origin of Species among Plants."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. Arthur G. Green, "Constitution and Colour." 2. Mr. E. Sonstadt, "Some Experiments on Sea Water." 3. Messrs. C. Revis and F. S. Kipping, "Derivations of α Hydrindone." 4. Mr. H. E. Armstrong, "Notes on Nitration." 5. Messrs. H. E. Armstrong and W. A. Davis, "2 : 3′ Bromobetanaphthol." 6. Mr. W. A. Davis, "Derivatives of Nitrobetanaphthols." 7. Mr. W. A. Davis, "Morphotrophic Relations of Betanaphthol Derivatives." 8. Miss C. Evans, "Researches on Tertiary Benzenoid Amines."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Fred. Enoch, "Wonders and Romances of Insect Life."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Paper by Mr. H. Brereton Baker.

FRIDAY, DEC. 4...Civil Engineers, 25, Great George-street, S,W., 8 p.m. (Students' Meeting). 1. Address by Mr. J. Wolfe Barry (President). 2. Mr. David W. Kinmont, "Railway Signalling."

Geologists' Association, University College, W.C., 8 p.m. Messrs. H. W. Burrows and Richard Holland, "The Foraminifera of the Thanet Beds of Pegwell Bay."

Philological, University College, W.C., 8 p.m.

Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

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FRIDAY, DECEMBER 4, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FOTHERGILL PRIZE.

The Council of the Society of Arts have awarded the prize of £25 and a silver medal for a paper on "The Best Means of Effectually Preventing the Leakage of Current to Earth in Electrical Installations from Generating Heat and Setting Buildings on Fire," to Frederick Bathurst, A.Inst.E.E.

The paper will be read at one of the Wednesday evening meetings after Christmas.

CANTOR LECTURES.

Professor Vivian B. Lewes delivered the second lecture of his course on "The Use of Gas for Domestic Lighting," on Monday evening, 30th November.

The lectures will be published in the *Journal* during the Christmas recess.

Proceedings of the Society.

THIRD ORDINARY MEETING.

Wednesday, December 2, 1896; Sir Owen Roberts, M.A., D.C.L., F.S.A., Treasurer of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Crawford, Mrs. J. A., 9, Victoria-street, S.W.
Fearon, Thomas Laurence, 27, Guildhall street, Folkestone.
Hills, Arnold Frank, Monkhams, Woodford-green, Essex.
King, William Isaac, The Grange, Highgate, N.
Winter, George Bliss, South Indian Railway, Trichinopoly, India.

The following candidates were balloted for, and duly elected members of the Society:—

Ackland, Charles George Heber, Catteral-house, Chestnut-avenue, Hampton.
Aris, John Whitton, B.A., Sherriff-house, 24, Sherriff-road, West Hampstead, N.W.
Aston, William Henry, 46, Eagle Wharf-road, New North-road, N.
Baden-Powell, Captain B. F. S., 8, St. George's-place, S.W.
Banerjee, Hon. Gooroo Dass, Narikeldanga, Calcutta.
Barrett, S., Moyeni, Quthing, Basutoland, South Africa.
Baxendale, A. S., Selangor, Straits Settlements.
Blackshaw, Walter, 65, Thornhill-road, Croydon.
Borgström, Henrik Emil Herbert, Helsingfors, Finland.
Bradberry, Charles Frederick, Battersea Works, S.W.
Bradford, Milton, 35, Queen Victoria-street, E.C., and 2, Old Park-avenue, Nightingale-lane, Clapham-common, S.W.
Brough, Bennett Hooper, 31, St. Leonard's-terrace, Chelsea, S.W.
Burkinshaw, William Parker, The West-hill, Hessle, near Hull.
Burt, George, 37, Grosvenor-road, S.W.
Cairncross, Thomas Wilson, Abbey Craig, Woodside-road, Cape Town, Cape Colony.
Chisholm, Robert F., Neuenheim, Heidelberg, Germany.
Collier, George, Dingle, Ireland.
Cookson, Alfred Chorley, 108, Manor-road, Brockley, Kent.
Cutting, Charles Henry, Parliament Works, Parliament-street, Derby.
Davidson, Charles Irvine, St. Gothard, Princes-road, Lewisham, S.E.
Davies, James Mair, 166, St. Vincent-street, Glasgow, and 46, Queen Victoria-street, E.C.
Dronsfield, Joseph Standring, Alexandra-park, Oldham.
Edye, Lieut.-Colonel Lourenco, Admiralty, Whitehall, S.W.
Field, James Hermann, Messrs. Taylor and Field, 14, Victoria-street, S.W., and Claremont, Woodberry-down, N.
Frecheville, William, Claremont, Nutfield, Redhill, Surrey.
Frewen, Moreton, B.A., 25, Chesham-place, S.W.
Gilbertson, Francis William, B.A., Glyn Têg, Pontardawe, R.S.O., Glamorganshire.
Gosnell, C. A., 93, Upper Thames-street, E.C.
Grant, William Henry, Foleshill, Coventry.
Gray, William Wythers, 4, Bene't-street, Cambridge.
Grimes, Herbert Thomas Redman, 27, Chancery-lane, W.C.
Harrison, Thomas, 85, Blenheim-crescent, Notting-hill, W.
Hart, Herman, 1, Melina place, N.W.
Himbury, William Henry, Bonny, West Coast of Africa, and New Lyric Club, Coventry-street, W.

Honeysett, Arthur, 39, Victoria-street, S.W., and 189, The Grove, Hammersmith, W.
Hopkins, John, Little Boundes, near Tunbridge Wells, and 79, Mark-lane, E.C.
Humphery, George Richard, 16, St. Donatt's-road, New-cross, S.E.
Jackson, A. M. T., M.A., Bombay, India.
Jennings, Arthur Seymour, 298, Friern-road, Dulwich, S.E., and 83, St. Paul's-churchyard, E.C.
Johnson, Harry Croom, The Elms, Wrexham.
Joseph, Francis Edward, Double Bay, Sydney, and Equitable-building, Sydney, New South Wales.
Keeson, H. V. Cuthbert, 40, Loudoun-road, St. John's-wood, N.W.
Kelly, Mark Jamestown, 7 and 8, Idol-lane, E.C.
Laurie, James, Government Marine Surveyor's Office, Singapore.
Lawrance, Walter, 8, Delahay-street, S.W.
Leaver, Cyril D'Arcy, 14, Horbury-crescent, W.
Leggett, Lieut. Edward Humphrey Manisty, R.E., Royal Arsenal, Woolwich.
Lister, Hon. Martin, Negri Sembilan, Straits Settlements.
Macaulay, Herbert, Crown Lands Office, Lagos, West Africa.
Marshall, Frederic, Q.C., 3, Harcourt-buildings, Temple, E.C.
Martin, Sir Thomas Acquin, Silverlands, Eridge, Sussex.
Meagher, J. J., J.P., St. Lucia, West Indies.
Millar, William Galt, 1, Arcade-chambers, Reading, Berkshire.
Mitchell, George Sharman, Upper Adhurst, Petersfield, Hants.
Mogren, Adolph, 164, Edmund-street, Birmingham.
Olubi, Jonathan C., Breadfruit-street, Lagos, West Africa.
Oswald, Herm E., Belize, British Honduras.
Oxley, Erneste, Melbourne-lodge, Clay Cross, Derbyshire.
Pfister, Frederick, 15, Fore-street, E.C.
Plunkett, Count George Noble, 26, Upper Fitzwilliam-street, Dublin.
Popple, John, Groves-hall, Sleights, near Whitby, and 47, Flowergate, Whitby.
Reid, James, Leadenhall-house, 101, Leadenhall street, E.C.
Reid, John R., 62, Park-road, Haverstock-hill, N.W.
Rochford, Joseph, Turnford, near Broxbourne.
Sansom, Alfred Edward, 198, Uttoxeter Old-road, Derby.
Scott, Prof. Robert Julian, Canterbury-college, Christchurch, New Zealand.
Shaw, James Stenhouse, 87, Newgate-street, E.C.
Simonds, George, The Priory, North-bank, St. John's Wood, N.W.
Spink, Henry, 36, Goldstone-villas, West Brighton.
Stewart, Captain James, D.L., Alltyrodyn, Llandyssil, South Wales.
Sugg, John Walter, Knollbrow, Dorking, Surrey.
Sutton, Arthur Warwick, Bucklebury-place, Woolhampton, Berks.
Thomson, Surgeon-Major General William Arthur, care of Sir C. R. McGrigor, Bart., and Co., 23, Charles-street, St. James's-square, S.W.
Valentine, Charles Richard, Whitcliffe, Grove-park, S.E.
Weir, William Park, Aviemore Railway Works, Carr-bridge, Inverness-shire.
Welton, William Smart, 73, The Chase, Clapham-common, S.W.
West, Frank Adamson, 22, Sheppard-street, New Swindon, Wilts.
While, Alfred Mounier, 42, Westbourne-road, Sheffield.
Wingate, Hamilton M., care of James Wingate and Co., 4, North-court, Royal Exchange, Glasgow.
Withers, Samuel, care of The Brayton Petroleum Motor Company, Hythe-road, Willesden Junction, N.W.

AND AS HONORARY CORRESPONDING MEMBERS:—

Agassiz, Alexander, For.Memb.R.S., Cambridge, Mass.
Berthelot, Professor Marcellin, For.Memb.R.S., Grand Officer Legion of Honour, Perpetual Sec. Acad. des Sciences, Paris.
Brandis, Sir Dietrich, K.C.B., Ph.D., F.R.S., Bonn.
Bunsen, Professor Robert Wilhelm, Ph.D., For. Memb.R.S., Professor of Chemistry, University of Heidelberg.
Cannizzaro, Professor Stanislao, For. Memb.R.S., Senator, University of Rome.
Cleve, Professor P. T., Ph.D., University of Upsala.
Ferrari, Professor Galileo, Turin.
Fresenius, C. Remigius, Ph.D., Wiesbaden.
Giglioli, Professor Italo, Naples.
Langley, Professor Samuel Pierpoint, LL.D., Secretary, Smithsonian Institution, Washington, D.C.
Lindström, Johann Edward, Stockholm.
Mascart, Eleuthère Elie Nicolas, For.Memb.R.S., Memb. Inst. de France, Bureau Central Météorologique, Paris.
Mendeleef, Professor Dmitri Ivanovitch, LL.D., Ph.D., For.Memb.R.S., St. Petersburg.
Schneider, Henri, Creusot, France.
Sellers, William, M.Inst.C.E., Philadelphia.
Steinheil, Dr. Adolphe, Principal of the Optical Institute, Munich.
Vambéry, Professor Arminius, Budapest.

The paper read was—

THE TEACHING OF ECONOMICS.

By W. A. S. Hewins, M.A.

My object in this paper is not to sketch an ideal method of teaching a system of abstract doctrine on which no two economists are likely to agree, but to suggest a practical means of organising economic studies here and now. Professor Jevons pointed out twenty years ago that economics is not one science, but several. "We must distinguish the empirical element from the abstract theory, from the applied theory, and from the more detailed art of finance and administration." Each branch of the science appeals not to some average student, but to special groups of men and women engaged in different departments of business or public work. This condition must be kept in view in any scheme of organisation.

If it were proposed that every student at our schools and universities should study Mill's "Principles of Political Economy," there would be anything but a unanimous opinion in favour of the course. But I may assume that most educated people would admit the importance and the desirability of economic teaching so far, that they would prefer to know rather than not to know the economics of the questions which they have to deal with in the practical business of life, or in which public events or private reading arouse, it may be, a passing interest. Many are willing to make sacrifices in order to obtain a scientific training in economics, and I believe there is a growing opinion that from the point of view of national interests it is desirable to create a demand for economic teaching where none at present exists. Even if it were desirable, it is impossible for everyone to undertake with profit a course of instruction in abstract economic theory. But much fruitless discussion of some absurd proposals might be avoided if the generalisations of that science could be widely disseminated. Economic history, particularly that of England in relation to foreign countries in modern times, is not only valuable as an educational force, but is full of suggestiveness and warning. There is no branch of public or municipal work which would not gain in efficiency if officials were thoroughly trained in some one or more branches of applied economics, such as finance, or statistics. Last year we had rather more than 300 students at the School of Economics; this year we shall have many more than that number. They consist of 10 or 12 different groups of persons. Each group is a mere fraction of a large class. Each class has to be approached by different methods. If we had the means of so extending and improving our organisation that the teaching we provide could be brought to the notice of all who would value it, and explained to them by personal interviews—the only satisfactory plan of obtaining students—I see no reason in the nature of things why the numbers I have mentioned shouid not be multiplied tenfold.

While the importance and the possibilities of economic teaching are so great (I have spoken only of London), what are the present facilities in England for obtaining a scientific training? In what I have to say on this matter, I must point out that I have only had personal experience of Oxford University, two of the local colleges, the University Extension movement, teaching and examining in connection with schools, various university and other institutions, and the work of the London School of Economics. At Oxford, one paper in economic theory and economic history is set in the Honour School of Modern History. Compared with the other subjects of examination economics occupies an unimportant place. It is generally recognised amongst undergraduates that it does not pay to divert much of their energy from constitutional, political, and foreign history to the study of economics. A few of the best men, no doubt, read Mill or Walker, and such works as Rogers's "Work and Wages," Cunningham's "Growth of English Industry and Commerce," and Toynbee's "Industrial Revolution." But generally speaking the subject is neglected. In Litt. Hum. economics occupies a more subordinate position. A few questions on the subject are set in one paper. In the Pass Schools it is an optional but a widely chosen subject. Candidates for Group B_3 are examined in Walker's "Political Economy," and selected portions of Adam Smith's "Wealth of Nations." An intelligent man can get through with very little work. An unintelligent man will, with the aid of coaching, take from one to three, or even more, terms. A by no means small proportion of the candidates fail on the first trial. There are weighty objections to raising the standard, and on the whole this examination is the most important provision made for the subject at Oxford. Some encouragement to the higher study of economics is given by the Cobden prize, and under the new research statute it is possible for a candidate to specialize on the subject.

At Cambridge, economic studies have been organised up to a certain point with energy and success. Both the Moral Science and the Historical Tripos have attracted men and women with an aptitude for economic reasoning and research. Many of the candidates in these examination have afterwards achieved distinction in the economic world; and the teaching at Cambridge is more systematic, thorough, and continuous than at Oxford. In addition to the honour examinations, economics is one of the special subjects which may be taken up for the ordinary B.A. degree. The examinations include papers in general economic theory, taxation and finance, and the economic functions of government. The position of economics in the examinations of the Universities of Durham and London is not sufficiently important to stimulate the study of the subject. In spite of the fact that University and King's Colleges have as professors two of the most distinguished economists and the ablest lecturers in England, the attendance at these lectures appears to show that there is no spontaneous demand in London for economic teaching.

"In the Victoria University," says Professor Gonner, "Economics, comprising political economy and economic history, forms one of the twelve optional subjects, of which two have to be selected for the final year of study by candidates for the pass B.A. degree, the two other subjects being more or less restricted. Economic theory or history may also be taken in conjunction with modern history as one subject by candidates who wish, for instance, to take modern history but not ancient history. As, however, nearly all the other subjects are, with some difference of standard or period, subjects at the intermediate or second-year examination, in some instances compulsory, and again in certain cases, subjects at the final examination, the study of economics, involving as it does the entry of the student upon a wholly new subject during his final year, is naturally discouraged. Further, economic theory (political economy), like any other arts or science subject, may, by permission, be substituted for one of the two selected general subjects, ethics or modern history, at the intermediate stage of the Law degree (LL.B). A course of lectures in political economy has to be attended by candidates for the Honours degree in history. It is not a subject in the examination."*

In these circumstances, it is idle to look for any large number of students in the economic classes of the Owens College, Manchester, and University College, Liverpool. The study of the subjects which are vitally necessary for success in the examinations will naturally take all the available time of the students. In the University of Wales, it is possible for a student to obtain some guidance in economic studies, but the direct encouragement given to the subject is too slight to be of any moment. Even under the present system, a considerable number of men take economics in the Civil Service examinations. But economists have long regarded the meagre requirements of the Civil Service with great dissatisfaction. Their repeated efforts, however, to obtain wider recognition of the subject have not met with success. In grammar schools, girls' high schools, and other secondary schools, some impetus has been given to the elementary study of economics by the system of local examinations, in which it is an optional subject. As a rule, I believe it is more usually taken up by girls than boys. Another class is reached by the examinations of the Society of Arts, the Institute of Bankers, the London Chamber of Commerce, and other bodies. The examination of the Society of Arts includes both economic theory and economic history, and some of the questions are framed with a view of giving candidates an opportunity of showing an advanced knowledge of the subject.

In the university and other institutions I have so far mentioned, economic studies depend almost entirely on the position they occupy in examinations. It is no doubt true that some students at the universities devote time and energy to the subject without reference to the examinations, and receive guidance in their work from the professor, or other teacher. But the number of such students cannot under existing circumstances be very large. During the period of residence, which usually ends when the degree is obtained, it is very difficult, frequently impossible, to do more than the work of the "School," and at the same time take a rational part in athletics, the Union, college societies, or other branches of undergraduate activity. So that economics cannot usually be studied by the undergraduate. Until the recent establishment of research degrees at Oxford and Cambridge, there was no inducement to reside after taking the B.A. degree, except the hope of achieving distinction in another "School" or Tripos, or of obtaining a fellowship.

I come now to institutions or societies, or other means of organising economic studies, in which the desire to pass an examination is not the motive for undertaking a course of training. First amongst such institutions I place the London School of Economics. I cannot give you a briefer account of the work of the school than is contained in papers issued by the school :—

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* Report of the committee of Section F. (Brit. Ass. 1894).

"The school commenced work in October, 1895, at 9, John-street, Adelphi, W.C. No similar attempt had before been made to organise economic and political studies in England. The school is already the largest centre of systematic training in those subjects in the United Kingdom. During the first year more than 300 students have joined the school. Of these, 100 have undertaken the whole or part of the three years' course of study established at the school, or have been engaged in other systematic work; the remaining students have confined their attention to special courses of lectures, and the classes in connection with them. Of the total number of students, 75 are women. The lectures and classes have appealed especially to those who desire the guidance of experts on particular subjects. The students consist of graduates of British and foreign universities, women students of the universities, and are mainly engaged in the research department of the school, and of civil servants, local government officials, railway officials, young men and women engaged in business, bank managers and clerks, teachers and other persons engaged in public work.

"During the first year 570 lectures have been given, or an average of nineteen a week. Individual students have also received private tuition. The work of the school has been carried on both in the morning and in the evening after 5 p.m.

"A three years' course of training in Economics has been established, including:—(*a*) First Year's Course: I. Outlines of Economic Theory, II. Outlines of Economic History, III. Methods of Investigation; (*b*) Second Year's Course: I. (i) History of Economic Theory; (ii) Critical study of the leading economic writers; or II. Detailed study of the economic history of England in relation to that of foreign countries; or III. The Principles of Finance and Taxation; or IV. Statistics, including course of training in framing forms of inquiry; tabulation; interpolation; investigation of casual relations between economic phenomena by statistical method; applications of the law of error; graphic method of statistics; (*c*) Third Year's Course: I. Methods of Investigation; II. Authorities; III. Practical Work under supervision.

"Lectures have been delivered and classes held in the following subjects:—Economic Theory and History, Statistics, the State in Relation to Industry and Commerce, Economic Effect of Alien Immigrations, Railway Economics, Influence of Geographical Conditions on Commercial Development, Trade Routes, &c., the History of the Poor Law, the History of the State Regulation of Wages, the History of English Commerce, the Commercial Policy of England in Relation to her Colonies, the Law in Relation to the Exchange and Distribution of Wealth, the History and Principles of Banking in England, the History and Principles of Local Rates, Principles of Taxation and Finance, Palæography, the English Constitution, German Social Democracy, and the Referendum.

"In the research department, much useful work has been done by the students on such subjects as the History of Enclosures, the Poor Laws, the History of Economic Theory, Modern Labour Problems, Factory Legislation, and later Constitutional History.

"With the view of encouraging the elementary study of economics and political science, a limited number of scholarships, tenable at the school, has been awarded to selected students from University Extension and other classes in economics. Five research studentships, of from £100 to £25 each, have been awarded after an examination held in July, 1896, for the promotion of special investigations into problems of economic and political science.

"The publication has been commenced of a series of 'Studies in Economics and Political Science,' containing the results of reseaches conducted by the lecturers at the school or under their direction. Two volumes have already been published, viz.: (i.) 'The History of Local Rates in England,' by Edwin Cannan, M.A.; (ii.) 'Select Documents Illustrating the History of Trade Unionism.' I. The Tailoring Trade. Edited by F. W. Galton, with a preface by Sidney Webb, LL.B. Other volumes are in the press.

"A sum of more than £1,500 has been obtained with a view to the establishment of a Library of Political Science. Amongst the subscribers are the Clothworkers' Company, the Earl of Rosebery, the Duke of Devonshire, Mr. A. J. Balfour, Mr. J. Chamberlain, the Earl of Onslow, the Lord Chief Justice of England, the Marquis of Ripon, Lord Tweedmouth, Sir George Trevelyan, Lord Brassey, Sir John Lubbock, Sir John Hutton, Professor Marshall, Professor Edgeworth, Sir Robert Giffen, Sir Alfred Milner, Lord Thring, Sir Alfred Lyall, Mr. W. E. H. Leeky, Miss Payne-Townshend, Mr. and Mrs. Sidney Webb, Canon and Mrs. Barnett, Sir J. C. Dimsdale, Lord Rendel, and Lord Welby.

"The school has become an important centre of information for British students and foreigners visiting England for the purpose of investigation. Relations have been established with foreign institutions, and guidance as to sources of information has been given to students from Belgium, France, Germany, Italy, the United States, and other countries."

On the method of organisation adopted in connection with the school I shall have some observations to make presently. I may, however, at this point state that it would have been impossible to attempt so large a scheme but for the generous help and co-operation of the Technical Education Board, the Society of Arts, and the London Chamber of Commerce.

I come now to the University Extension

system, which has been associated throughout its history with the popularisation of economics.

In recent years, however, economics has lost ground in the centres, except those of the London Society for the Extension of University Teaching. I notice that in the Oxford programme of arrangements for this and next session, economics, using the term with its widest signification, is represented only by such courses as "English Colonies," "Social and Industrial Questions since 1789," "Social Utopias," and "Social Reformers." None of these courses consists of more than six lectures. In the Cambridge centres, the announcements include only one course of twelve lectures on "Political Economy," and in those of the Victoria University one course of six lectures on the "Industrial Revolution." This is a disappointing record. In the early days of the Oxford movement some of us expected to see by this time the establishment of thorough and systematic courses in the larger industrial centres. London has in this matter saved the reputation of the University Extension Movement. In the announcements for Michaelmas term I notice no less than ten courses of twelve lectures in the certificate course department, of a scientific as distinguished from a popular character, and one course in the pioneer department. To these must be added several courses dealing with such subjects as commercial geography and colonial expansion. This encourages the hope that University Extension will play an important part in the organisation of economic studies in London. I have recently had some opportunities of forming an opinion on the character of the work done, and I have no hesitation in saying that so far as it goes it is highly satisfactory. The principal drawback to University Extension courses of lectures on economics has been that it has been impossible to provide teaching of a more advanced character, or to induce even the best students to continue their studies. This is due, not so much to any special defect in the University Extension system as to the absence of public institutions in which advanced work could be carried on. The exhortations of a lecturer are, as a rule, quite unavailing unless there is some outward and visible embodiment of a higher range of ideas than those which the student has already mastered. The mere existence of economic libraries and teaching institutions, quite apart from the work done in them, is not without value as an educational force. The greater provision of economic courses in the London University Extension centres has been accompanied by, at any rate, the beginnings of a similar movement in connection with some of the Polytechnics. I may particularly mention the Borough-road Polytechnic, where I believe it was found impossible to arrange for a University Extension course, but short courses of lectures accompanied by systematic classwork of an elementary character, have been provided.

There is one branch of educational work in economics which is not usually mentioned in a review of this kind, I mean the educational lectures and classes of various societies, some propogandist, like the Fabian Society, others, which desire to be considered impartial, like the Christian Social Union. The lecturers of these societies are perhaps of one, or at most, of three ways of thinking. But the subject-matter of the lectures is derived from received economic treatises and works on English economic history, and though the lecturers may, no doubt, interpret events in their own way, I believe that, as a rule, they are content to go to the best available authorities for the facts, and to explain them in as scientific a manner as possible. Lectures, meetings for discussion, and correspondence classes of this kind are a valuable influence, stimulating the scientific study of social and economic questions. The Fabian Society's list of books on economic subjects, which is widely circulated, is an admirable bibliography. It was, I believe, the first attempt to popularise a knowledge of the best and cheapest books on various departments of economic investigation. Some of the leaflets and suggestions for reading issued by the Christian Social Union are very well prepared, and have a wide influence. It is worthy of note that the first economic quarterly—the *Economic Review* — was published by the Christian Social Union. The contributors represent all schools of thought. The quarterly article on "Legislation, Parliamentary Inquiries, and Official Returns" is the most readable and, at the same time, exhaustive account of official publications relating to economic subjects published in England. The *Economic Review* was followed by the *Economic Journal*, published by the British Economic Association. Although it is scarcely equal in value to the best German periodicals, it has done much to place England on a par with the Continent in this respect. Both the *Review* and the *Journal* appeal to a wider circle of readers than the *Journal of the Royal Statistical Society*, which, however, frequently contains important contributions to economics. If to these we add the papers and periodicals dealing with the more technical applications of economics and statistics, such as the *Economist*, the *Bankers' Magazine*, and the *Assurance Magazine*, it will be seen that England is not ill-supplied with publications of an economic character, though it is far behind the Continent in respect to those devoted to economic theory and economic history.

I am afraid I have detained you too long with this review, brief as it is, of the present condition of economic teaching in England; but there are several important points in connection with it to which I must draw your attention. I shall omit, for the present, the London School of Economics, which has been in existence for too short a time to have exercised a marked or decided effect on the general situation. I will summarise what I have to say as briefly as possible.

1. Though the aggregate of the work done is considerable, the provision of economic teaching in England is beyond expression meagre in proportion to the needs of the community. It is no answer to say that the community is weary of economists, and does not wish for instruction. If that is so, either the community or the economists are at fault. As a matter of fact, I am strongly convinced that, while no spontaneous demand for scientific training in economics can be said to exist, the indifference is largely due to the absence of any satisfactory provision for the subject in our educational system.

2. England is far behind the continent of Europe and the United States. If a man wishes to devote himself to economic investigation, it has hitherto been necessary for him to obtain his intellectual outfit from Germany, France, and the United States. Economics is essentially an international study. Under no circumstances can one country provide all that is necessary. The student of English problems can always gain from the consideration of methods of dealing with them in foreign countries. Foreigners are alive to this, and come to England in large numbers every year. They go back, and write books on English economic questions better than anything published here, with the result that, in some quarters, research is supposed to mean the study of German books based upon English materials.*

3. Not only are the facilities for economic training in England inadequate and meagre compared with those provided on the continent, but the teaching already given is one-sided, incomplete, and badly organised. Most of it is elementary and theoretical, and probably leaves scarcely any permanent impression on the minds of the students. The higher branches of economics are scarcely touched by the present educational system. Here and there isolated students or small groups are doing advanced work in economic theory, or carrying on investigations in the neglected field of economic history. But the amount of work done is so small, that economic history can scarcely be said to be seriously studied in England. Statistics, finance, the economics of public and municipal administration, railway economics, commercial geography, and many other important branches of the subject are in the same or a worse position. In Cambridge, where economic studies are much better organised than anywhere else in England, there is plenty of room for improvement. The provision made in Oxford cannot be said to be in any respect worthy of a great university.

4. There are no "prizes" in the economic profession. The professorships are few in number, and poorly paid. The community purchases this form of ability on the cheapest possible terms. No English economist could live on his salary in the manner required of him, and at the same time provide for old age and the ordinary incidents of family life. The result is, that much ability, which might be exercised in economic work, is diverted into more profitable vocations. It is just possible for a man to earn enough to live with extreme economy by combining together several different economic sources of income, such as lecturing, writing, and coaching. But this requires not only unusual ability, but perfect health and unremitting toil. I am constantly asked by men and women students of ability as to the prospect of economic work. They are willing, even anxious, to devote themselves to the subject and are never, so far as I am aware, attracted to it by the hope of pecuniary advantage. But unless they have private means, and in most cases they may have a little but not enough to support themselves, they must have a reasonable chance of earning a small income. Not even that can be guaranteed.

5. One result is that there are many important departments of economic investigation

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* For a good account of economic teaching on the Continent see the "Report of the Committee of Section F of the British Association (1894)."

on which no books are to be found, and many others on which there are only books of inferior quality.

6. The teaching of economics cannot be made to pay its own way. University Extension experience shows that popular courses of lectures on economics, if they are very well organised but not too frequently arranged, are not necessarily unsuccessful. But the centre must be prepared to run the risk of a deficit. It is quite impossible without help of some sort to establish in a University Extension centre a permanent or even long-continued course of instruction in economics. If the difficulties of organising popular and elementary courses, without public grants, endowments or private help, are so great, it would be folly to expect the higher branches of the work to pay. I will go so far as to say that if advanced and research courses show a balance on the right side, either the work done is not what it pretends to be or the teaching must be largely gratuitous, and therefore, in most cases, inefficient.

What then is to be done?

I pointed out at the commencement of my paper that my object was to suggest a means of dealing with the existing situation. I have not to suggest a scheme of economic training for a country in which local needs are everywhere the same, in which no training of any kind has hitherto been given, and all are agreed as to the kind of teaching to be provided. In order to clear the ground, I venture to make the following suggestions:—

1. Is it clear that the best method of improving the position of economics in the educational system of the country is the modification of existing examinations, or the creation of new ones? Are we not beginning at the wrong end by adopting this method? I suppose I may assume that the object of teaching is not to enable people to pass examinations, but to impart useful knowledge, of the quality of which an examination may or may not be a good test. If that is so, it appears to me that before you invent a test, you want something to test. I know that the reason why so much importance is attached to this method of reform is that certain examinations are a condition of obtaining degrees. But in order to include economics in the syllabus, you must show clearly to those whose business it is to bring about the change, that economic training promotes the objects for which the examinations exist, and unless you have definite and measurable results to quote in support of your claim, the satisfaction of it may be in the future, as it has been in the past, indefinitely postponed. I do not exclude the modification of the examination system as a means of reform. Some evidence of its desirability can always be found, and is always accumulating. Those interested in the promotion of economic studies should, without doubt, persistently urge the claims of the subject to wider recognition. But I suggest that this is one of the most circuitous and difficult methods of obtaining the object in view, and not the simplest and the easiest. You no sooner start an agitation for changing the character of an examination, than you arouse all sorts of hostility. You must have an unanswerable case, strong influence, and skilful diplomacy if the agitation is to be successful.

2. The claim of economic training to public support must be based upon its practical usefulness. Does it make people more efficient? Does it enable them to understand the public questions of the day? Does it diminish social and economic friction? In many cases the question asked is, "Does it enable a man to earn more money?" Some people will always take a more exalted view of the province of economics. One would naturally expect to find such persons in the universities. But the majority will generally apply a more narrowly utilitarian test, and take what is called the "bread and butter" view of economics.

3. In practice, at any rate, it is necessary to demonstrate the usefulness, from many points of view, of economic training before a satisfactory number of students can be induced to attend lectures and classes. It is absolutely futile to launch ideal programmes in the hope that they will appeal to some hypothetical average student or students. As I have previously mentioned, the students at the School of Economics are drawn from several quite distinct groups of men and women in different departments of business, professional or public work, and although having regard to the extreme difficulty of organisation and the comparative dearth of men with the requisite qualities, who are free to undertake work in London, we have achieved considerable success, we are still a long way from that complete correspondence between the teaching provided and the needs of the students which we hope to realise in the future. I do not suggest that in framing syllabuses of instruction you should cut down the programme to those subjects, and the manner of treating

them, for which there is already a demand, or for which a demand can be most readily created, but that in framing your syllabus, you should form a perfectly clear conception of the people for whom your lectures and classes are intended, find out their needs from those who are in a position to test the efficiency of their work, and then, by personal negotiation and other means, get into touch with your potential students, and persuade them to make use of the lectures and classes. This requires trained experts in different departments for lecturers and careful organisation.

I suggest, then, that the first step in the solution of the general problem is the organisation of commercial and professional education. That this is possible, even without legislation, though legislation might, in many ways, promote the object in view, is evident, from the experience of the Technical Education Board and the School of Economics. If you have a county council keenly alive to the importance of higher commercial education, and a responsible educational body in a position to provide organisation and expert knowledge of the subject it is proposed to teach, even a small grant will go a long way towards establishing a good system of instruction. But I am strongly of opinion that, in no circumstances, should a grant be made under vague conditions, but only for definite courses to be delivered, by experts to be approved by the council, in response to a genuine demand.

The subjects on which courses of instruction could be arranged include such as the following:—The history of trade and commerce; tariff relations between England and other countries; the history of special trades; the development of special lines of commerce; foreign and colonial trade; commercial treaties; development of the means of communication; inland navigation; shipping; railways and canals; railway economics and administration; companies; syndicates; trusts; the influence of geographical conditions on commercial and trade development; trade routes, &c.; water supply, distribution of population; the causes of the localisation of particular industries; the history and principles of banking and currency in England and foreign countries; the foreign exchanges; insurance; commercial and industrial laws; finance and taxation; public and municipal administration; statistics in relation to (i.) insurance, (ii.) industry and commerce, (iii) finance and taxation; and many others; all of which would be of direct practical utility to different groups of people, and ought to be included in a well-devised and comprehensive scheme of technical and commercial education.

Interesting questions arise in connection with the co-ordination of courses of lectures and classes, and the work of different institutions. But these cannot be fruitfully discussed except in relation to the actual circumstances of different localities. I wish to trace the effect of such a scheme on the study of other branches of economics. It may be said that the organisation of commercial education on the lines I have suggested would simply mean the establishment of a number of unrelated courses of instruction of a narrowly technical character. I do not take that view. Certainly our experience at the School of Economics does not point in that direction.

I am not so optimistic as to suppose that even in the most favourable circumstances such a scheme as I have described could be rapidly and generally carried into effect. One serious difficulty would be the absence of a sufficient number of experts. But if these studies were satisfactorily organised in a few only of the great industrial centres, there would arise a considerable demand for the services of properly qualified teachers and lecturers. Young men at the universities would speedily begin to think of the work as a possible career. Some would gravitate to those studies which, for want of a better word, I will describe as rather more academical than the rest; others, particularly men at the bar, would see in the new work an opportunity of acquiring reputation, knowledge, and experience, as the basis of a successful practice. Now experts such as are required, are not easily made or readily found. Mere text-book knowledge is useless. To teach successfully the students I have in view, a man requires, in addition to his academical training, special acquaintance with one subject, a thorough grasp of economic theory, and the history of at least English industry and commerce, some knowledge of the world, experience in investigation and research, ability as a lecturer, and some capacity for organisation.

Here would occur the opportunity of the Universities. They could not supply all the necessary qualifications. They can only be acquired gradually by the sort of experience which a University cannot give. But the Universities could train men up to the point at which some of the subjects could be undertaken with a fair chance of success, and the work itself would do the rest. Oxford might turn out men well qualified in all branches of economics which require careful historical training; Cambridge, its statisticians; Victoria University, men well versed in the economics of modern industrial and commercial questions. In each University there should be a laboratory for training and investigation in those subjects for which it is peculiarly fitted. In the case of London alone no selection of appropriate subjects is necessary, because nearly every branch of economics can be studied with greater advantage here than in any city in the world. In no city has there ever occurred so splendid an opportunity.

DISCUSSION.

Mr. MARTIN WOOD thought the paper would arouse a great deal of interest, especially in the North and other parts of the country where there was more activity shown on this subject than in London, saving always the efforts of the School of Economics. Many years ago he had the good fortune to obtain the first prize in political economy at an examination of the Society of Arts, and later he was for some years examiner in the same subject for the Bombay University, and in that way was able to form an opinion on the current methods of teaching, and their effect on the students. No doubt many of the shortcomings which had been referred to were due to the impractical manner of teaching the subject, and not the least so at the universities. Too much attention, he thought, had been given to the scientific and abstract part of the subject, and too little to its application as an art. Of late years he had noticed a tendency to go to the other extreme, and to include in political economy a number of matters which belonged rather to commercial education and general information. At the same time these subjects could not be properly understood without a grounding in economic science, for want of which all sorts of practical mistakes were made, for instance, even in that room, they had heard men otherwise eminent, speak on currency questions in a way which showed they had not grasped the principles which were involved. Again, the city editors, who were mostly monometallists and wedded to the English system, seemed for a long time quite unable to comprehend the position taken up by bimetallists; whilst these, on the other hand, very often confounded together the functions of token money and legal tender. All this showed the need for more definite elementary teaching. The unpopularity of the study was greatly due he thought, to the stiff and awkward way in which it was often treated, though some allowance must be made on account of its wide extent, for rightly understood it covered a very large proportion of the whole field of human exertion, and it appealed to the faculties common to the great majority of mankind. Its importance it was scarcely possible to exaggerate; technical and scientific instruction was highly important, but even the results thus gained could not be practically and usefully applied without a due acquaintance with economic principles. Of late years there had been a change from the pedantic method of teaching economy, an illustration of which will be found in the recent address by Lord Farrer at the Cobden Club. He would be reckoned an old-fashioned economist, but towards the close of his address he alluded to the manner in which the leading principles of economy had been taught and held by most authorities, and referred to the doctrine of diminishing returns, to the Malthusian theory, and to Ricardo's theory of rent, which he said had been treated as abstract statements of principles; and though he did not suppose Lord Farrer meant to dispute the scientific importance of those doctrines, he went on to indicate that teachers had often forgotten to allow for the qualifying circumstances, which made very great care necessary in applying them to the actual facts of daily life. One of the mistakes made by University professors had been in treating land in exactly the same way as other property, not discriminating sufficiently the essential difference between rent, as the result of the possession of a natural agent limited in extent, and other property which was produced by labour and the expenditure of capital. They had been taken at their word with fatal facility by Fabians and others, and the demand was made for the nationalisation of all the agents of production, no distinction being made between those natural agents which were limited in quantity and other natural agents which were unlimited, and therefore had no price, and agents which were produced by labour and capital, and were limited only by their application. When he was an examiner at Bombay, he generally had as colleagues men in the Civil Service, or otherwise engaged, and they usually put questions out of the text-books, Mill's being largely used. The students had generally good memories, and the answers they gave to such questions did not give any adequate measure of the value of what they had learned. He generally took a rather different course, such as had been suggested in the paper, and set questions which not only required a knowledge of the principles set out in the text-books, but also of how they should be applied. The result was, on the whole, encouraging: about one-third of the students did very well; another third did so far well as to show that they knew the principles involved, while the remaining third failed. Mr. Hewins had referred to the deficiency of text-books and manuals; but, with all deference, he thought there was a large number of good text-books, but they were perhaps rather fragmentary. There must be in various magazines and reviews many articles and papers of great value, and probably one of the best services the School of Economics could render would be to collect and republish such papers, annotating them, and bringing them up to date. Reference had been made to the superior teaching of economy in Germany and America, and he could not help mentioning the great facility and clearness with which the French writers treated these subjects. He hoped the London school would be a great success, especially as it would have a better material to work upon than the universities, its students being persons engaged in practical business, rather than young people who simply took up the subject for the sake of passing an examination, and then dropped it.

The CHAIRMAN, in proposing a vote of thanks to Mr. Hewins, said the first time he met him was some nine years ago, when he was at Huddersfield, in reference to some work connected with the Clothworkers' Company. He there found that the Technical College had courses of lectures in connection with the University Extension system, and he was astonished at the wide scope embraced by the syllabus of lectures on political economy. Since then he had taken a deal of interest in Mr. Hewins' career, and was very glad to find that the London School of Economics had secured his services. He felt that he was quite a new man in his mode of dealing with economic subjects, and the sciences and arts auxiliary thereto, and he firmly believed that he had a great future before him in connection with this school. It was peculiarly desirable that such a school should be established, having regard to the fact that there were important questions now pending of a political and economic character, and it was highly desirable that those who had to solve them should understand something about them. With regard to the difficulty of finding students, he was inclined to suggest that the question of compulsory and free education for members of Parliament in this subject might well be considered, with possibly a qualifying examination before election. He thought there would be a considerable number of exclusions as the result of such a test. He should be rather interested to see what sort of an examination certain prominent statesmen would pass. He was not at all sure that a similar examination for the London County Council would not be productive of good results. There were new problems arising in the future with regard to which the public weal would be immensely advanced if more interest were taken in these questions, for unless they were grappled with in a scientific spirit, disastrous consequences might ensue. It used formerly to be said that civil servants, like the fountains in Trafalgar-square, played from 10 to 4; but those days, if they ever existed, were over, and the Civil Service comprised some of the best educated and most hard-working men in the country. When he trembled, as he sometimes did, at the ignorance of legislators, he was re-assured by remembering that at the Board of Trade, and in other public offices, there were intelligent hard-headed trained men who would keep the amateurs straight. The men in the higher branches of the Civil Service had very high intellectual, as well as administrative qualifications, but their work was anonymous, and was not, he feared, properly recognised. In the lower division also there were very many able men, and he was glad to think that a hard and fast line was not always drawn between the two divisions, and that gentlemen in the second division, who were worthy of it, were sometimes promoted, not only into the first division, but over the heads of some of those who were already there. There was now growing up also a municipal Civil Service, hardly inferior to that of the nation, and having regard to the experiments which were being tried in local administration, it was highly desirable that the public should be protected in the same way against blunders and disasters, as they were in connection with the Imperial administration. He was therefore very glad to hear of the London School of Economics being established, and he believed when the new teaching University of London came into being, which it ought to have done long ago, the School of Economics would find congenial soil, for London was the true centre for such studies. Oxford and Cambridge were all very well, but there was an academic and non-practical atmosphere about them which was not observable in London. Mr. Hewins had referred to the fact that it was not possible for any one man to cover the whole ground—that there must be specialists in economics as in other mattters; but when he thought of the admirable lectures given by Mr. Acworth on railway economics, and other courses by other gentlemen, he thought it showed there were gentlemen in London who, if they could not deal with the whole of these subjects, were quite able to deal with them in detail, and as long as they had a man like Mr. Hewins, who was able to take a comprehensive view of the whole situation, there was in that arrangement a fairly ideal mode of treating the subject. They had been trying to improve the technical education of the country for some years, and though some blunders had been made, still some progress had been achieved, but England was not only a manufacturing country, but essentially a commercial one, and London was the centre of commerce. The School of Economics dealt with the question of distribution rather than with manufacture, and it did seem to him that London was the proper home for such a school. He was sure that this paper, when it was read—as it would be—by thousands of people, would do a great deal to arouse the public interest in the important subject with which it dealt, and that many would come forward to give the author a helping hand in pushing on the ideal which he had so ably put before them.

The vote of thanks having been carried unanimously, Mr. HEWINS, in reply, said he was very thankful for the opportunity of addressing the Society, and explaining what he thought was the best way of organising teaching on this subject. He feared that, perhaps, the paper might give the impression that he underrated the more abstract side of political economy, but that was certainly not his desire. At the School they taught the most advanced and abstract theory as well as the more practical subjects he had described. In fact, though they were in the main intensely practical, they had also more advanced study of abstract principles than anywhere else in England. The point really was this—Whom were you going to teach? Where were the students to come from? While for the full comprehension of some of the exceedingly practical questions he had named, a thorough training was required not only in abstract economy, but in the higher mathematics, it would be unwise, and perhaps untrue, to say that in order to improve his knowledge of the question with which he had to deal, every student must master the differential and integral calculus, and the higher branches of economics. There were certain parts of statistics and banking and currency principles which were highly theoretical in their essence, but which could be explained to, and to a certain extent assimilated by people who could not devote years to special study, and that work had to be done, and must be done. Unless teaching met a general demand, the public would have no control over economists, and he was much in favour of keeping economists in touch with the practical needs of the actual world. As a matter of fact they did not want a series of extremely abstract generalisations which applied to no known form of human society, ancient or modern. They wanted generalisations of a scientific character, but they must be the results of thinking in the concrete, not in the abstract. Economists should be not like the people who criticised pictures, but like those who painted them. That was the difference between true abstract thought and untrue. He did not consider it any derogation to a science to say that it was practical and useful, and it was surely the highest mark of the benefit to be derived from a science, that it could contribute a little to the solution of the immensely difficult problems with which they were face to face at the present time. No school of economics could be excluded. The higher mathematical school was needed as much as the empirical. After all, statistics rested on the theory of probabilities, which was highly mathematical; and many cases occurred in which the question arose of the credibility of witnesses, and the value of the testimony they gave, and that again was a question of probability, and ultimately rested on a mathematical basis. But it was not necessary to bring this forward at every opportunity, or in relation to every student. The thing was to take the student at the point he had reached, and teach him to go as much higher as he desired. That was the plan adopted in the school, and so far the results had been encouraging. Many of those who took up the study from practical motives remained till they became passionately fond of it. Some of the best students at present had been attracted at first by purely ordinary and commonplace motives, but they stuck to it, and some of them were likely to achieve real distinction. There might be too much mere abstraction. It was much more important to have a perfectly true, accurate, and living study of the manner in which one of the old trading companies worked than to have some vague historic generalisation which did not convey any impression to the mind. That was the great argument for specialisation. The world had become so complex that no single economist could possibly arrive at all the generalisations required to make a complete science. When there were more specialists trained to the highest possible efficiency, devoting themselves to the subject, he believed the economic situation in England would speedily show signs of improvement.

Miscellaneous.

OLIVE CULTIVATION IN PERSIA.

A concession was granted by the Shah's Government to a Greek firm under Russian protection, in May, 1890, giving it a monopoly for the purchase and working of all the olives in Northern Persia. This is only now being put into operation by the establishment of a properly constituted factory on the most approved system. The factory is being rapidly built, and machinery, mostly English, has already arrived. Her Majesty's Consul at Resht says, that in view of the establishment of this factory, it may be of interest to know the manner in which olives were treated hitherto, and the probable results of the monopoly in question. Northern Persia is now said to possess some 130,000 olive trees. The olive grows in the valley of Roodbar, which is traversed by the present Resht-Jehran high-road. It is also cultivated in the district of Genjeh, nearer Resht, and in Taroum to the south. On the right bank of the Sefid Rood the principal villages are Kilishter, Viaieh (where the new factory is established), Rezehgah, Geldian, Hurzevil, and Mengil, as well as about thirty less important villages. There is a tradition that the olive trees of Roodbar were brought from Syria by a colony sent there by Tamerlane, or Ameer Taimour, but nothing is known for certain as to the actual date of their introduction into the country. Olive trees are grown irregularly, too close together, and shoots are seldom cut off, the consequence is that one often meets with clusters of half a dozen or more trees within a radius of five or six yards. The trees are never pruned or trimmed in any way; manure is occasionally given, a plentiful watering however, is given once a week regularly. Persians of these uplands are adepts at the irrigation of land by means of their streams of water turned off from the main streams and torrents. The water question is the most important of the daily life of a Persian peasant, and there are more quarrels on that account than any other in that country. The olive groves are at altitudes varying between 500 and 2,000 feet above sea level. The climate in those parts is dry, and the rainfall is slight, as testified by the flat mud roofs of the habitations. Ten miles north of Kilishter the houses have shingle sloping roofs, the vegetation is ample, and no artificial irrigation is resorted to. Twenty miles further north is a dense forest, much undergrowth, the land is swampy in places, and the rainfall heavy. There are immense forests of oak and beech, these forests rising to an altitude of 7,000 feet. The highest mountain in these parts is 8,150 feet high, and has a glacier which supplies Resht with ice whenever the ice houses of the town itself run short. Each full-grown olive tree in a good year yields from five to six Rahmetabad batmans of olives (a batman of Rahmetabad is equal to 17 lbs. avoir.). Taking the lower estimate this would bring the yield per tree to 85 lbs., and the total yield per year on the average would be about 6,000,000 lbs. Most of the olive oil hitherto extracted in the districts under notice has been employed in soap making. It is said that on an average 200 horse loads of soap, of 20 *mans* per load is exported each month from the olive districts. This would bring the amount sold, roughly speaking, to some 800,000 lbs. The natives of the olive-growing districts eat the black olives, and use the oil for cooking purposes. The average price of soap at Resht is one *kran* (fourpence) per pound. This would bring the total produce to about £16,000. When in late autumn the others are ripe and black, they are collected by shaking the trees and striking the branches in the same manner as walnuts are obtained. The olives, when collected, are boiled for an hour, and are then dried in the sun. After this they are pressed under foot in a trough which reduces the olives to a paste. The paste is then placed in an earthenware jar and heated, it is afterwards placed in bags and pressed, when the oil is extracted. This oil is kept several months in jars, and can be kept for years without deteriorating. In order to make soap they purchase *kaliab*, or alkali, in Taroum; they have lime on the spot. There are about ten houses where soap is manufactured in the village of Kilishter. The best soap is made in this village. Since the price of olive oil has risen, suet is added in equal proportions to olive oil in soap making. The soap made without the addition of suet is, when kept, of an excellent quality, and well adapted for washing clothes, and all rough work generally. The Greek firm intend to induce the owners of olive groves to sell them their entire crops by offering them more remunerative prices than they have hitherto obtained. They will manufacture table olive oil of the best quality with the greater part of the olives, the residue being used for soap making. With their machinery they will be able to extract the whole of the oil from the olives, which is far from the case by the present primitive methods described above. Their intention is to sell the oil in Russia, where there will be a ready sale. A good margin of profit should remain, when it is remembered that Persian produce is only taxed at 5 per. cent. *ad valorem*, whereas European products pay very heavy tariff rates. Consul Churchill says it should not be concealed, however, that some apprehension exists in the native mind that if the Europeans purchase all the olives, the price of soap will increase enormously in the districts in question, and some hostility exists towards the firm on that account.

THE INDIA-RUBBER INDUSTRY OF NICARAGUA.

Localities in Nicaragua south of latitude 15° north, and between longitude 84° 10′ and 85° 35′, in low valleys where the soil is deep alluvial or deep vegetable humus or sand, and capable of being rapidly drained, and in a climate that is almost uniformly warm and humid, suit the largest rubber yielding varieties of trees and vines. Some varieties, however, giving an excellent quality of very elastic rubber, are indigenous to a higher, dryer climate and soil. According to a United States Consul at Managua, there are several varieties and species of the natural orders *Urticaceæ*, *Sapotacæ*, *Moracæ*, *Aponaceæ*, and *Euphorbiacæ*, indigenous to Nicaragua, which, when scarified deeply, exude a milk-like sap, from which rubber of various degrees of elasticity is separated. The quantity annually, and the quality as regards elasticity, differ usually with the species and with different favourable or less favourable localities. Some prefer the low alluvial lands under a humid atmosphere, as in the north and south valleys in eastern Nicaragua, while other varieties flourish best in more elevated, sandy, and decomposed vegetable matter—lands rich in potash, as the volcanic valley districts south of Lake Nicaragua, and forming the peninsula of Cosequena. The most desirable varieties for quantity and quality of rubber per annum are the *Siphonia elastica* and *Castilloa elastica*, habitants of well drained, low, alluvial valleys, that are usually kept warm by a humid atmosphere. The second best rubber producers, in quality and quantity, are of the ficus family, a variety locally known as Matapala, an epyphite having numerous trunks or bodies from aerial roots, like the banyan tree. It is also an inhabitant of low, fertile, well-drained lands. By cultivation, this tree would most probably equal the other low varieties in quality and annual output of rubber. It has the advantage that if one of its trunks or bodies is deadened by excessive bleeding or drainage of the sap, it has several other live trunks from which to obtain supplies of rubber. Another good variety is of the species *Manihot balano*, locally known as the "arbolde vaca," or "palo de reche de vaca" (cow milk tree), a large, tall, hardy, indigenous kind, found at altitudes of 1,000 to 2,000 feet above the ocean. The quantity of the annual yield depends—the climate and soil being suitable—upon the bulk of the bast or lactiferous tissues that exist or that can be developed in the tree or vine. Some trees of 2 to 3 feet diameter and 35 to 50 feet high, will give annually 20 to 40 pounds of good rubber. The quality of the rubber depends largely upon the shape or form of the cells and spaces composing the bast or lactiferous tissue, and in part in the process used to separate the elastic material from the emulsion-like sap. As regards the planting and cultivation, the seeds are sown in beds, and transplanted to a nursery when one year old, and thence removed to their permanent place, when from two to three years old, in rows of 20 by 20 feet for the Castilloa; 22½ by 22½ feet for the Siphonia, and 25 by 25 feet for the Matapala or ficus variety; or about 64 Matapala, 81 Siphonia, and 100 Castilloa trees per acre. Cultivation consists in ditching the land so as to drain it slowly or rapidly at will, keeping it moist without permitting water to stand in pools or low places. During the rainy season it is drained rapidly. All undergrowth is kept cut down, and the land banked around the trees in cone shape to about 6 inches higher than the general level, within 5 feet of each tree. In collecting the rubher, operations are commenced during the sixth or seventh year of the tree's age by making small incisions through the bast, taking, if the trees have matured properly, from 8 to 12 pounds of rubber from each tree biennially, but after the tree is 12 years old, a sufficient quantity of the sap or emulsion can be annually extracted from each tree to yield from 10 to 15 pounds of good rubber. Among the several modes of incision the two following are said to be the best:—(1) Cutting with a curved sharp instrument channels through the lactiferous tissues; (2) driving tubes cut from the internodes of bamboo (abundant in Nicaragua) through the bast or lactiferous tissue, first making a slanting cut of a part of the circumference of the tube and driving the sharpened end 1½ to 2 inches long into the tree. When the collecting season is past, the tubes of that season are plugged up with wood that has been dipped in some liquid insecticide, and the tube is then sawn off together with its wooden core, even with the thin exterior bark of the tree. The coagulation of the milk-like exudation, and the separation from it of the elastic material can be effected by heating to about 170 degrees Fahrenheit, and stirring in a hot decoction of the leaves and twigs from some species of convolvulacæ. Secondary crops, planted between the rows of rubber-producing trees, might consist of Liberia coffee, plantains, bananas, or such fibrous plants as henneqen or sisal, also the ramilla bean vine (one vine to each rubber tree), which would yield an annual crop equal in value to the rnbber product.

Notes on Books.

A TEXT-BOOK OF BACTERIOLOGY. By Edgar M. Crookshank, M.B. Fourth Edition. London: H. K. Lewis. 1896.

There can be few branches of science of which the progress has been so rapid as that of the study of micro-organisms. It may indeed be said to be the creation of the last half of the present century, for though, as Professor Crookshank tells us, Kircher, nearly two and a-half centuries ago, expressed a belief that there were definite micro-organisms to which diseases were attributable, the opinion thus put forward remained for some two hundred years an opinion merely until the discovery by Cagniard Latour and Schwann, that the yeast plant was a living organism, brought up again the doctrine of *contagium vivum*, and the researches of Boehm, Bassi, and Henle demonstrated its truth at all events in certain cases.

From that time (about 1840) to the present, an army of eager workers have devoted themselves to the study of bacteriology, and have devised, to assist themselves in their investigations, a vast number of singularly ingenious processes and methods. The difficulties attendant on the study cannot easily be over-estimated. Its objects are so minute that they are only discernible by the use, in skilful hands, of the higher powers of the best microscopes. They are living creatures, and must, therefore, be studied in a living state, a condition which implies their preservation often for a considerable period of time. Each species has to be isolated, in order that its independent action on its surroundings may be estimated, and it has not only to be separated from the other similar organisms amongst which it may be found, but preserved from the contamination of the ubiquitous microbes and spores with which all air is charged, and which are present under all conditions, and on all materials.

It was long before it was even found possible to exclude bacteria from any material or any space of air. Then it was discovered that matter once perfectly "sterilised" would remain unaffected by bacteria if sealed in a receptacle containing only sterilised air, or air from which the bacteria had been removed by filtration or deposit. Thus putrescible matter could be preserved in a flask plugged with cotton wool, or one to which air was admitted by a bent tube. In such flasks or tubes, therefore, the various species of bacteria can be separately cultivated, once they are isolated from each other. This isolation may be effected in various ways. If the organism is grown in a liquid medium, the homœopathic practice may be adopted of separating small fractions and diluting them, repeating the process till such a condition of dilution is reached that it may be estimated that a small portion of the liquid contains only the pure species required. This device has, however, been superseded by the process adopted by Koch, who developed the microbes in a nutrient jelly. This jelly was poured out on a glass plate, on which each organism developed round itself a growth or "colony" of similar organisms, each colony being necessarily a pure culture. Such pure cultures are also obtained in practice by simply conveying a trace of infected material on the point of a sterilised needle to a tube of nutrient gelatine or other suitable medium.

Another device which has proved of great value in bacteriological study is that of staining the specimens, and thus facilitating their microscopical examination. If a cover-glass (such as is used for covering a microscopic preparation) carrying such a specimen of bacteria, be passed rapidly twice or thrice through the flame of a bunsen burner, most of the matter on it will be so scorched as to be incapable of taking any stain from a solution of an aniline dye. The microbes themselves, however, are able to resist the heat, and they will be deeply coloured when submitted to the same dye. Or after dyeing, the colour may be discharged by weak nitric acid from some organisms, while others retain it. Thus the spores may be coloured, while the bacteria are left colourless, or are stained by a further process with a different colour. By the application of these and similar methods, these minute organisms, and even their several parts, have been made not only visible, but capable of being photographed.

The first part of the book under review gives a very full and detailed account of the methods and apparatus employed in bacteriological investigations, and in the study of the etiology of diseases. The most suitable form of microscope is described, and full instructions are given for the photography of bacteria, a special form of camera being described which admits of ready combination with the microscope. The methods of culture are fully dealt with, the apparatus used and its manipulation.

The second part deals with infective diseases, and the bacteria associated with them. Among the specific diseases (of animals and man) which are treated may be mentioned anthrax, swine fever, fowl cholera, cholera plague, pneumonia, typhus, yellow fever scarlet fever, measles, small-pox, diphtheria, typhoid, tuberculosis, leprosy, glanders, tetanus, rabies.

The third part is "systematic and descriptive;" it contains descriptions of about five hundred bacteria. There are appendixes dealing with yeasts and moulds; hæmatozoa in men and animals; and other animal micro-parasites. There is also one giving the apparatus, material, and reagents employed in a bacteriological laboratory, and one dealing with the bibliography of this subject. A supplementary appendix gives extracts from the report of the Vaccination Commission, the conclusions of which appear to have Professor Crookshank's sympathy, for he insists strenuously throughout his book on the importance of stamping out diseases. Of small-pox he goes so far as to say:—

"Isolation should be uniformly enforced all over the country, and vaccination should be relegated to the position of a voluntary auxiliary measure, which should never be allowed to take the place of sanitary regulations to stamp out the disease."

The book is throughout sumptuously illustrated. There are twenty-two plates, nearly all coloured, and 273 woodcuts, some of which, though printed in the text, are also coloured.

CARRIAGES WITHOUT HORSES SHALL GO, being a reprint of a paper on "Horseless Road Locomotives," read before Section G of the British Association, Liverpool, September 23, 1896. By A. R. Sennett. London: Whitaker and Co.

The author has given in this paper an historical account of the various attempts which have been made to obtain a satisfactory horseless carriage, and has reprinted the discussion, in which the merits of the various modes of obtaining the motive power were discussed. The pamphlet is very fully illustrated, and Mr. Sennett has added to his paper some remarks on the future of horseless road locomotion, in which he urges the necessity for the enforcement of a rule of the road for the pedestrian, and suggests that the pedestrian should follow the same rule as that adopted for vehicles. There are also notes on the new enactments; a reprint of the Locomotives on Highways Act, 1896; notes on 'Evolution in Modes of Travel'; the *Engineer* Competition, 1897; and Local Government Board regulations concerning the running of self-propelling vehicles made necessary by the passing of the Act. Mr. Sennett points out that in France there is a properly organised system of instruction for the management of the carriages, and that it takes about fifteen days to become a "horseless coachman."

Obituary.

GILBERT WILLIAM CHILD, M.A., M.D.—Dr. Child, who died at his residence, Headington-hill, Oxford, after a long illness, was a member of the Society of Arts, and took much interest in the Society's Sanitary Conferences. In 1878 he read a paper before the National Water Supply Congress. Dr. Child was a member of Exeter College, Oxford, and obtained a second class in Natural Science in 1854. He was Lecturer on Botany in the Medical School of St. George's Hospital, and also Hon. Physician of the Radcliffe Infirmary, subsequently becoming Medical Officer of Health for Oxfordshire. He was Public Examiner in the School of Natural Science as well as for the M.D. degree at Oxford. In later years he withdrew from practice. He was for many years an active member of the Court of the Clothworkers' Company and filled the office of Master. He published works on physiological subjects, and also a work entitled "Church and State under the Tudors."

General Notes.

Italian Woollen Industry.—In the entire kingdom of Italy it is estimated that there are now 6,303 mechanical and 3,685 hand looms, without counting the small hand looms at the homes of the operators. The most important woollen factory in Italy, according to Consul Bright, of Catania, is that at Schio, with 2,200 operatives. The mills of Italy number 431, with 121 steam and 406 hydraulic motors, and give work to 30,240 operatives; the spinning and combing mills number 11, with 4,258 operatives, of which the oldest and most important is that of Borgosesia, with works for dyeing, weaving, and other purposes. In threads of combed wool the production of the country is insufficient for the demand of the weaving and knitting establishments. There exists in Italy, as stated above, 6,303 mechanical, and 3,685 hand looms, or in all, 9,988, besides the small home looms. Estimating the production of each loom at 10,000 lire, gives the total annual value of 99,880,000 lire of Italian production. Adding to the 34,653,355 lire as representing the value of the woollen tissues introduced into Italy from foreign countries, and the total value becomes established at 132,553,555 lire.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

December 9.—"Mining at Great Depths." By Bennett H. Brough, Assoc.R.S.M. Professor H. Bauerman, F.G.S., will preside.

December 16.—"The Chamber Music of Purcell, Handel, and Bach." (With Illustrations on the original Instruments for which it was written.) By Arnold Dolmetsch.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

Prof. Vivian B. Lewes, "The Use of Gas for Domestic Lighting." Three Lectures.

December 7.—Lecture III.—Gaseous illumination where coal-gas is not available—Oil-gas and its properties—Acetylene: its manufacture and use—Acetylene burners and generators—Railway and tramcar lighting.

MEETINGS FOR THE ENSUING WEEK.

Monday, Dec. 7....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian B. Lewes, "The Use of Gas for Domestic Lighting." (Lecture III.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 6 p.m. 1. Annual General Meeting. 2. Mr. F. Street, "Sheep Breeding."

Royal Institution, Albemarle-street, W., 5 p.m., General Monthly Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7¼ p.m. Mr. George Thudichum, "The Ultimate Purification of Sewage."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. Alfred E. Fletcher, "The Alkali Manufacture: An Historical Sketch." 2. Messrs. H. F. Hunt and L. J. Steele, "Notes on the Spontaneous Oxidation of Aluminium in contact with Mercury."

Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. William Crookes, "The Diamond Mines of Kimberley, with special reference to the origin and nature of the Diamond."

Surveyors, Savoy-street, Victoria-embankment, W.C. 8 p.m. 1. Adjourned discussion on Mr. Walter C. Ryde's paper on "The Agricultural Rates Act, 1896." 2. Mr. C. H. Hooper, "Fruit Growing as an Auxiliary to Agriculture."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Col. J. K. Trotter, "A Journey to the Sources of the Niger."

Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Mr. Hormuzd Rassam, "Biblical Lands, their Topography, Races, Religions, Languages and Customs, Ancient and Modern."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. W. S. Lilly, "The Mission of Tennyson."

Tuesday, Dec. 8......Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. James Rigg, "Tipping and Screening Coal." 2. Mr. Thomas Gillott, "The Surface-Plant at Kirkby Colliery."

Photographic, 12, Hanover-square, W., 8 p.m. Dr. Neuhaus, "Dr. Selle's Process for Natural-Colour Photography."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Sir Harry H. Johnston, "England's Work in Central Africa."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Imperial Institute, South Kensington, S.W., 8½ p.m. Major John C. Neild, "Australian Federation."

Asiatic, 22, Albemarle-street, W., 4 p.m.

Wednesday, Dec. 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Bennett H. Brough, "Mining at Great Depths."

Sanitary Institute, 74a, Margaret-street, W., 8 p.m. Dr. Samuel Rideal, "Soils and their suitability for Sewage Farms, with the Role of Bacteria in Sewage Disposal."

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

Central Chamber of Agriculture (at the House of the Society of Arts), 11½ a.m. Annual Meeting.

Thursday, Dec. 10...Royal, Burlington-house, 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Professor John Milne, "Unfelt Movements of the Earth's Crust."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Annual General Meeting.

Mathematical, 22, Albemarle-street, W., 8 p.m.

East India Association, Town Hall, Westminster, S.W., 3 p.m. Sir H. S. Cunningham, "The Indian Famines."

Friday, Dec 11...National Association for the Promotion of Technical and Secondary Education (at the House of the Society of Arts), 2 p.m. Annual Meeting and Conference.

Astronomical, Burlington-house, W., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Mr. C. Chree, "The Application of Physics and Mathematics to Seismology." 2. Mr. R. J. Rudd, "Musical Tubes."

Saturday, Dec. 12—Botanic, Inner Circle, Regent's-park N.W., 3¾ p.m.

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FRIDAY, DECEMBER 11, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening 7th inst. Prof. VIVIAN B. LEWES delivered the third and last lecture of his course on "The Use of Gas for Domestic Lighting."

On the motion of Mr. FRANCIS COBB, Chairman, a vote of thanks was passed to the lecturer for his interesting course.

The lectures will be published in the *Journal* during the Christmas recess.

FOREIGN AND COLONIAL SECTION.

In consequence of January 19th being the date fixed for the opening of Parliament, the first meeting of this section is unavoidably postponed until Tuesday evening, February 2nd. At this meeting an opening Address on "The Growth and Progress of the Colonies during the reign of the Queen," will be delivered by the Right Hon. Sir Charles Wentworth Dilke, Bart., M.P. The chair will be taken by the Right Hon. the Earl of Jersey, G.C.M.G.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 6 and 13, 1897, by CLINTON T. DENT, F.R.C.S., Past President of the Alpine Club, on "The Growth and Demolition of Mountains." The lectures will be fully illustrated with lantern slides and experiments. After a brief sketch of the growth of mountains, the following points will be discussed in the course:—The agencies which contribute to the demolition; wearing and weathering of rock; protective and destructive influence of glaciers; avalanches—the Altels avalanche in 1895—mountain falls—bursting of glacial lakes.

The lectures will commence at seven o'clock. Special tickets are required for these lectures, which can be obtained on application to the Secretary. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. The cards are now ready for issue.

Proceedings of the Society.

FOURTH ORDINARY MEETING.

Wednesday, December 9, 1896; Professor H. BAUERMAN, F.G.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Armstrong, James G. D., H.M. Office of Works, Tunbridge Wells.
Doggett, William Charles, 17, Holborn-viaduct, E.C.
Donkin, Harry Julyan, 55, Southwark-park-road, S.E.
Fraser, Claud, 187, Gloucester-terrace, Hyde-park, W.
Geoghegan, Henry Thomas, 16, Faraday-mansions, Queen's Club-gardens, West Kensington, W.
Hall, Joseph, Municipal-offices, Cheltenham.

The following candidates were balloted for, and duly elected members of the Society:—

Browne, Major Alexander H., Callaly Castle, Whittingham, R.S.O., Northumberland.
Carter, George Henry, 65, Torriano-avenue, Camden-road, N.W.
Walsh, Thomas M., Tuam, Co. Galway, Ireland.

The paper read was—

MINING AT GREAT DEPTHS.

By BENNETT H. BROUGH, Assoc. R.S.M., F.I.C., F.G.S.

The recent announcement* that the Red Jacket shaft of the Calumet and Hecla mine in the Lake Superior copper region has been sunk to a depth of 4,900 feet, the greatest depth hitherto reached by a mine-shaft, opens up a large field of speculation as to future developments of mining at great depths. The subject is one of great importance in view of the rapid exhaustion of the thicker and more accessible

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* *Mining Journal*, September 26th, 1896.

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seams in the British coalfields, and in view of the attention which at the present time is being devoted to the working of deep-level auriferous deposits in the Transvaal, California, and New Zealand. It appeared, therefore, that a well-considered summary of the existing literature of the subject, supplemented by observations made during visits to the mining districts of the Transvaal, Lake Superior, and the Continent, would not be out of place in the proceedings of the Society.

A.—DEPTHS HITHERTO ATTAINED.

The epithet "deep" applied to a mine is a relative term. Early in the last century a shaft 60 fathoms in depth was an object of wonder, and tracing the history of the depths hitherto attained, the rapid progress in this respect is apparent. The first systematic writer on mining, Agricola,* describes mine shafts as being for the most part 2 paces long, ⅔ pace broad, and 30 paces deep. This depth had, however, been greatly exceeded in classic times at Laurium, where silver-lead mines were worked on a large scale by the ancient Athenians. There were 2,000 well-like shafts, many of which still exist and give a good idea of deep mining at that epoch. The workings were carefully laid out with the aid of geodetic instruments, a sighting instrument, and a water level, the use of which was described by Hero of Alexandria in the 3rd century B.C.

The shafts were perpendicular, square in section, two yards across. The deepest was 360 feet, but most of them did not exceed 80 feet. These shafts are fully described in J. F. Reitemeier's "Geschichte des Bergbaues bey den alten Völkern" (Göttingen, 1785), in B. Caryophilus' "De antiquis fodinis" (Vienna, 1757), and in A. Cordella's "Le Laurium" (Marseilles, 1869).

As a rule in those ancient times, of which we have records in the works of Herodotus, Diodorus Siculus, and Pliny, the mines were of small depth. The rock was generally not difficult to deal with, the minerals extracted were of great intrinsic value, and labour was plentiful and cheap, or, as in the Egyptian and Athenian mines large numbers of slaves were employed.

In this country the mines worked in the early days were evidently very shallow. A variety of details regarding the working of a small colliery, belonging to the monks of Durham and situated in the vicinity of the city, are preserved in the Durham Household Book,* which contains the accounts of the bursar of the monastery during the years 1530-1534. At this 16th-century colliery five men were employed, who were paid an aggregate sum of 21d. or about 4d. each per day. The pits worked a very small area, lasting less than a year; but the cost of sinking new ones was a mere nothing, ranging from 2s. 6d. to 5s. Among incidental charges are payments for winding ropes at 2s. each, and windlasses at 2d. each.

At the end of the 16th century, shafts were sunk from 70 to 120 feet deep. They were drained by water-levels or adits which were, we are told, very expensive, costing £20 or more. The invention of blasting at Schemnitz,† in Hungary, in 1627, rendered it possible to mine at greater depths. Blasting was introduced into this country by German miners at the Ecton copper mines in 1638,‡ and in 1689 it was adopted in the Cornish mines.

In 1668 the shafts of the Mendip lead mines were 4 feet by 2½ feet, and were remarkable in the early days for their depth. Indeed, an ancient charter exists of the date of Edward IV. (1408) which, in a rude attempt at plan drawing, curiously represents the "Myne deeps" as they were then called. Writing in 1670, Sir John Pettus § describes the shafts of that period in the following terms:—

> "The *Shaft* is that which is digged round or square, like a Well, from which the Earth that is digged is wound up in Baskets by Ropes, as we do buckets of water; and these are not only for that use, but likewise to give air to the Mine. Now oftentimes Pumps are put into these *Shafts* to fetch out the Water, for these *Shafts* are in many places 40, 50, or 60 fathom deep before the Miners come to the *Metal* or minerals for which they dig."

In 1672 George Sinclair|| described the pumping operations in the North of England in colliery shafts 420 feet deep in the following words:—

> "But there are to be seen in the North of England, in Bishoprick, water-works by which water is drawn above 40 fathom in perpendicular, but not all in one

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* "De Re Metallica," 1556, Book V.

* Published by the Surtees Society, Vol. xviii., and quoted by Mr. R. L. Galloway in the *Colliery Guardian*, July 24th, 1876.

† Neusohl archives quoted in "Jahrbuch der k. k. geologischen Reichsanstalt." 1867. p. 367.

‡ Bishop Watson's "Chemical Essays." London, 1781. Vol. i., p. 332.

§ Sir John Pettus. "Fodinae Regales." London, 1670, p. 2.

|| "The Hydrostaticks." Edinburgh, 1672, p. 298-299.

sink. The manner whereof is this, there being a sink from the end of their level to the surface of the earth where their works are going 40 fathom deep which must dry the coal sinks at 60 to 70, which lie above the banks of the river. Where the water-works are situated there is first one 40 fathom deep from the grass; another in a right line from that of 24; another of 12; upon all which there are water-works."

According to Robert Plot,* the collieries at Beaudesert in 1686 were the deepest in this country. Here cannel coal was mined at a depth of 240 feet. Dr. Plot describes with great minuteness the working of coal at Tunstall, in North Staffordshire, where ancient coal-pits, 3½ feet in diameter and 36 feet deep, have recently been discovered. Waller, in his essay on the value of the mines late of Sir Carbery Price, in 1698, mentions (p. 48) the Rudolphus shaft in Hungary as having attained the great depth of 108 fathoms, and the Leopold shaft that of 150 fathoms. These figures he obtained from Edward Brown's† Travels.

Similar statements are made by J. B. Merin,‡ who describes a visit to the Schemnitz mines in 1615. Though giving an interesting picture of the state of mining at that date, his description can hardly be considered scientifically accurate, as he gives great prominence to the appearance in the mines of "demons in the shape of little negro boys."

In 1700,§ some shafts on the Continent were 120 feet deep, 9 feet long, and 4 feet wide. The author of the "Compleat Collier,"‖ in 1703, mentions shafts as deep as 250 to 369 feet. The cost of sinking them amounted to £1,000 and more. The majority of the shafts, however, did not exceed 120 to 180 feet, and their cost was not more than £55.

The earliest applications of the steam-engine were directed solely to the drainage of deep mines. Savery, in 1702, in his pamphlet on the subject entitled "The Miners' Friend, or an engine to raise water by fire," described the first application of steam, but Newcomen and Crawley, in 1710, were the first to render the steam-engine suitable for practical use. The introduction of the steam-engine, crude as it was, rendered it possible to sink deeper shafts.

In 1755 the Potosi mines were remarkable for their great depth. The ladders there are stated* to have been made of cowhide. They were 10 fathoms in length, and with their aid men carried ½ cwt. up 150 fathoms.

In 1786 we are told by de Morveau that the deepest mines in England were at Whitehaven, and in East Northumberland shafts were often to be seen 50 fathoms deep.

At the beginning of the present century, in the North of England shafts were usually 8 to 10 feet in diameter.† Here and there, the equipment of shafts remained in a primitive condition. Even in 1837 a land-sale colliery was in operation in the county of Durham, at which coals were drawn by a donkey, and banked out and sold by an old woman. Nevertheless, there were some fairly extensive collieries, and some ambitious undertakings were begun, notably at Wearmouth colliery. Here shaft-sinking began in May, 1826; it reached 344 feet in August, 1831, was metal-tubbed in October, 1834, reached 1,578 feet and struck coal. In April, 1835, it was down 1,590 feet. The cost is said to have been £80,000 to £100,000.‡ For many years this was the deepest colliery in the world.

Thus, in 1830, it was a miraculous achievement when a shaft approached 300 fathoms. At this period, in the Cornish tin-mines, the wonderful improvements of the steam-engine caused mines which had been stopped for want of steam-power to be materially deepened, and large quantities of ore rendered available, which would otherwise never have been reached. Wheal Abraham had then obtained a depth of 1,452 feet, Dolcoath 1,410 feet, whilst Tresavean copper-mine was 1,920 feet deep below the adit level.

At the present time, Dolcoath (2,582 feet) is the deepest mine in Cornwall, its neighbour, Cook's Kitchen (2,436 feet), taking the second place.

The deepest shaft in the United Kingdom is that of the Ashton Moss Colliery, near Manchester, which has attained a depth of 2,880 feet. The seams dip at the rate of 9 inches per yard, so that parts of the workings are now 3,360 feet deep.* Even this depth has been exceeded at the Pendleton Colliery, where, Mr. Israel Barker, the manager, informs me, an incline of 1 in 3 has been sunk 4,700 feet long from the bottom of the shaft, which is 1,575 feet deep. The greatest vertical depth attained is, therefore, 3,474 feet. Many other deep shafts are over 1,800 feet, whilst the workings extend to over 2 miles from the shaft. The raising of some 1,500 tons per day from such depths, as compared with 300 tons from a depth of 500 feet, gives an idea of the development that has taken place within a comparatively recent period.

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* "The Natural History of Staffordshire." Oxford, 1686, p. 125.

† "A Brief Account of some Travels in Hungaria." London, 1673, p. 98.

‡ "Churchill's Collection of Voyages and Travels." 1704. Vol. iv., p. 822.

§ B. Roessler, "Speculum Metallurgiæ Politissimum." Dresden, 1700, p. 53.

‖ "The Compleat Collier: or the whole art of sinking, getting, and working coal mines, &c., as now in use in the northern parts, especially about Sunderland and Newcastle." By F. C. London, 1703.

* "Essay on the Gold and Silver Mines of Peru." 1755, p. 26.

† J. J. H. Holmes. "A Treatise on the Coal Mines of Durham and Northumberland." London. 1816

‡ John Holland. "The History and Description of Fossil Fuel." Second edition. London. 1841. p 186

On the continent, the silver lead mines of Przibram, in Bohemia, in 1876, attained a depth of 1,000 metres (3,280 feet), and since that date, workings have been carried down for another 100 metres (328 feet). The Freiberg shafts, in Saxony, have reached the maximum depth of 2,060 feet, and those of Clausthal, in the Harz Mountains, 2,960 feet.

In America, the gold veins of California have been followed to a depth of 2,200 feet, and explorations have been made on the Comstock lode, in Nevada, to a depth of upwards of 3,000 feet, whilst the Lake Superior copper-mines have reached, in the case of the Red Jacket shaft of the Calumet and Hecla Company, the fabulous depth of nearly 5,000 feet, mentioned at the beginning of this paper.

Two shafts were begun by the owners of the neighbouring mine, the Tamarack Mining Company, in the spring of 1889, and the progress was as follows :—

To the end of	No. 3.	No. 4.
	Feet.	Feet.
August, 1889	128	54
August, 1890	600	500
August, 1891	1,211	1,029
August, 1892	2,226	2,030
August, 1893	3,426	3,080
February, 1894............	3,824	3,698

The cost in 1893-94 of sinking No. 3 shaft was £12 8s. 4d. per foot, and that of No. 4 was £12 15s. 7d. In each shaft 54 men were engaged. Early in the present year these two shafts were each 4,450 feet deep, and being situated at an elevation of 650 feet above Lake Superior, they penetrate far below the bottom of that lake, and, in fact, nearly three-quarters of a mile below the ocean level.

The accompanying list of the more important deep shafts will give a clear idea of the depth to which mining workings up to the present time have penetrated :—

DEEP SHAFTS.

	Feet.
United States :—	
Red Jacket, Calumet and Hecla, Lake Superior	4,900
Tamarack, Lake Superior	4,450
Yellow Jacket, Comstock, Nevada	3,123
California Mine, Colorado	2,260
Grass Valley, Idaho	2,182
Kennedy Mine, Jackson, California	2,150
Pottsville shaft (disused), Philadelphia and Reading Coal and Iron Company	2,000
Belgium :—	
Produits Colliery, Mons...............	3,937
Viviers shaft, Gilly	3,750
Viernoy shaft, Anderlues..............	3,300
Marchienne Colliery..................	3,117
St. André shaft, Poirier Colliery, Charleroi..........................	3,100
Ciply Colliery, Mons.	2,950
Houssu Colliery, Centre	2,300
Marihaye Colliery, Liége..............	2,100
Average depth of all Belgian collieries..	1,420
Austria-Hungary :—	
Adalbert, Przibram, Bohemia	3,672
Maria, Przibram	3,281
Anna, Przibram	3,100
Franz Josef, Przibram	2,900
Procopi, Przibram	2,900
Einigkeit, Joachimsthal, Bohemia......	1,750
Amalia, Schemnitz, Hungary..........	1,750
Great Britain :—	
Pendleton, Manchester (workings)	3,474
Ashton Moss, Manchester (workings) ..	3,360
Astley Pit, Dukinfield (workings)	3,150
Dolcoath Mine, Cornwall	2,582
Rose Bridge Colliery, Wigan..........	2,446
Cook's Kitchen, Cornwall	2,436
Harris' Navigation, Pontypridd........	2,367
Cadeby Main Colliery	2,250
Bickershaw Colliery, Leigh............	2,210
Moss Collieries (No. 4 pit), Wigan	2,205
Astley Pit, Dukinfield (shaft)	2,058
Niddrie, Portobello, N.B.	2,010
Wearmouth Colliery..................	1,722
Loanhead Colliery, Shott's Iron Company	1,700
Victoria :—	
Lansell's, Bendigo	3,302
Lazarus, Bendigo	3,024
Magdala, Stawell	2,409
Twenty-five gold mines exceed	2,000

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* These figures were kindly supplied by Mr. T. H. Wordsworth, New Moss Colliery, Limited, November 28th, 1896.

Germany :—	
Kaiser Wilhelm II., Clausthal, Harz	2,960
Einigkeit, Lugau, Saxony	2,620
Samson, St. Andreasberg, Harz	2,560
Frieden Colliery, Olsnitz, Saxony	2,515
Concordia Colliery, Olsnitz, Saxony	2,420
Hansa Colliery, Huckarde, Westphalia	2,330
Maria Colliery, Hongen, Westphalia	2,300
Camphausen Colliery, Saarbrucken	2,296
Freiberg, Saxony (maximum depth)	2,060
France :—	
Montchanin Colliery, Le Creuzot	2,300
Treuil Colliery, Saint Etienne	2,034
Hottinguer shaft, Epinac	2,000
Ronchamp Colliery, Haute-Saône	1,870
South Africa :—	
Robinson Deep, S.A.R.	1,991
Nourse Deep	1,578
Crown Deep	1,321
Langlaagte Deep	1,302
Jumpers' Deep	1,260
Kimberley Mine, Cape Colony	1,261
De Beers' Mine	1,097
Norway :—	
Kongsberg Silver Mine	1,900

The results here recorded afford clear evidence that a great many of the difficulties which were formerly connected with the sinking of deep shafts have now disappeared. The valuable inventions and appliances available to the mining engineers have rendered such sinking operations easy, and comparatively inexpensive. It, therefore, appears that no considerations of a mechanical nature need limit the prospective depths of shafts.

B.—OBSTACLES TO DEEP MINING.

The elements needing consideration regarding the limits of depth in mining, are :—

1. The decreasing capacity of deep shafts.
2. The increase in pressure.
3. The increase in temperature.
4. The increase in expenditure.

These four obstacles I now propose briefly to discuss.

1.—DECREASING CAPACITY OF SHAFTS.

It is obvious that the quantity of mineral extracted from a shaft diminishes in proportion to its depth. The methods adopted for obviating this inconvenience are as follows :—

(*a*.) Increasing the speed of winding.
(*b*.) Enlarging the skips or cages.
(*c*.) New methods of extraction.

(*a*.) *Increasing Winding Speed.*—Turning to the first of these methods, we find that the evolution of the winding arrangements forms one of the most interesting chapters in the history of mining industry. Starting with men or women carrying the mineral on their backs up ladders, the improvements successively introduced have been a pulley supported by a frame above the shaft; the hand-windlass, or the capstan; the whipsiderry (in which the bucket is drawn up by making a horse walk away from the shaft); the horse-whim; and the winding-drum, worked by natural water-power. This was followed by the winding-drum, worked by water-power, pumped up for the purpose; the winding-drum, coupled direct to the steam-engine; an automatic collision-preventing arrangement for slowing the wicker-baskets when they passed each other in the shaft, rendered necessary by the increased speed of winding; next, the introduction in 1833, by Mr. T. Y. Hall, of South Hetton Colliery, of guides and cages to convey the waggons to the surface; and lastly, we come to the improved winding-engines of to-day.

The invention of wire-rope, by Oberbergrath Albert, in Clausthal, in 1833, rendered deep-mining possible. Before that date, the cost of hemp-ropes for deep shafts was very serious, and often as much as 6d. per ton of output was required for their maintenance. The ropes at Wearmouth Colliery cost £550 per pair. They weighed $5\frac{3}{4}$ tons, and only lasted 10 months. Iron wire-rope has now been superseded by steel. At the deep shafts at Przibram, crucible cast-steel, with a tensile strength of 76 tons per square inch, was used up to 1885. Since then, special crucible cast-steel, with a tensile strength of 114 to 120 tons per square inch, has been used with most satisfactory results. At these mines the advantage of using tapering ropes is especially noticeable.

Flat steel ropes are in use in Belgium, at the Providence shaft at Marchiennes. They are made of eight parallel four-stranded ropes, tapered by reducing the number of wires in the strand from 12 to 11 and 10, the wire, which is of crucible cast-steel, of a tensile strength of 89 tons per square inch, being of the same diameter (0·08 inch) throughout. The breadth of the rope varies from 7·87 inches at the thick, to 6·69 inches at the thin end, and the average weight is 8·2 lbs. per foot. The winding engines of 2,000 horse-power have cylinders 43 inches in diameter, and 78 inches stroke, and draw a load of $12\frac{1}{2}$ tons ($6\frac{1}{2}$ tons for the cage and tubs, and 6 tons of coal) from a depth of 3,117 feet. The life of the rope is about 12 months.

At another deep Belgian colliery, the Sainte Henriette shaft of the Produits Company, at Flenu, aloe ropes are used to lift a load of 6½ tons from a depth of 3,937 feet. They are of flat section, with ten strands, tapering in breadth from 16·5 inches to 8·6 inches, and in thickness from 1·93 inch to 1·14 inch. The average weight per foot is 7·4 lbs. The life of these ropes is about 24 months.

At the deep mines of the Lake Superior copper region, machinery of a very high-class is employed. The following interesting particulars, for which I am indebted to Mr. John Birkinbine, Past-President of the American Institute of Mining Engineers, will serve to illustrate this.

In the case of one pair of quadruple engines at the Calumet and Hecla Mine, each engine has its four cylinders, 18 inches, 27¾ inches, 48 inches, and 90 inches in diameter, with a stroke of 60 inches, driving through gearing conical winding-drums 14 to 24 feet in diameter, and 12 feet wide, which lift cages carrying 6 tons of ore at the rate of a mile in 1½ minute.

At the Tamarack Mine, an average winding speed of 3,200 feet per minute has been obtained by a direct acting engine, having 42 by 84 inch steam cylinders, driving winding drums 30 feet in diameter. At the same mine a 32 by 84 inch engine, driving a double-conical drum 13 feet 6 inches to 36 feet in diameter, lifts a cage carrying 2½ to 3 tons 4,500 feet in 1½ minutes. These are vertical shafts.

At the Quincy Mine, there are two principal shafts. No. 6, on a slope of 51° 44′, has a total depth of 3,680 feet, the weight raised being about 6 tons. No. 2 shaft, with the same dip, has a total depth along the slope of 3,954 feet, the weight raised being 10 tons.

It is interesting to compare results obtained at these three mines with those obtained at English collieries. Three illustrations which are given on good authority may be cited. In the "Encyclopædia Britannica," 1877, Mr. Bauerman selects as a good example of modern winding, such as is required to draw 1,200 tons in 10 hours, that at Shireoaks Colliery, Nottingham. There the cage with a load of 34 cwt. in five tubs is raised from a depth of 1,548 feet in 45 seconds, an average of 2,100 feet per minute. Mr. Emerson Bainbridge cites as an illustration of swift winding a North Derbyshire colliery, where in June, 1890, as much as 6,309 tons was raised from a depth of 1,527 feet in 8½ hours. Figures of cage speed published by the North of England Institute of Mining Engineers in 1876 show that the greatest maximum speed of the cage in the shaft recorded was at Rose Bridge Colliery, where it reached 5,100 feet per minute, or about 57 miles an hour.

The selection of the best form of drum is a matter of importance in winding from great depths. It appears best to replace large and expensive drums by small ones, and to have more revolutions for each journey. This object is attained in the system of winding engines patented in 1866 by Mr. S. B. Whiting, the manager of the Calumet and Hecla Mine. In this system, there are two grooved drums, one directly in line with the other, coupled by two connecting rods. The rope from one compartment of the shaft winds round both of these drums for three turns and is then led to the other compartment of the shaft. In order to allow of winding from different levels the rope is led back round a sheave on a tension-carriage running on rails, and a steam winch is connected to it so as to adjust its distance from the shaft. The following are particulars of a winding plant of this type at the Red Jacket shaft:—

Depth of shaft	4,900 feet.
Size of shaft	13½ by 23 feet.
Diameter of rope	1¼ inch.
Diameter of drums	7 feet.
Cage speed per minute	1,900 feet.
Weight of cage............	2,500 lbs.
Weight of load............	3,000 lbs.

Remarkable economy in fuel and winding efficiency has been attained with the machinery designed by Mr. L. I. Seymour for the De Beers Diamond Mines, Kimberley, and built by Messrs. James Simpson and Co., of London. The plant consists of a pair of inverted vertical tandem compound condensing engines driving two reels, which are capable of carrying flat wire ropes 3⅝ by 13/16 inch. The winding is from the 1,200-foot level. Two automatically discharging skips are used, each weighing 4,400 lbs. and holding 9,600 lbs. of mineral. According to Mr. W. McDermott, on one occasion during a single shift of 11 hours 43 minutes, the weight of blue-ground raised was 3,665 tons. The engines have been in use for over 3 years, and consume only 2¼ lbs. of coal per horse-power per hour.

For highest speeds, vertical shafts and wire-rope guides are absolutely necessary. In metal mines time is saved by adopting vertical shafts and cages instead of inclined shafts and skips. The number of loading places should be reduced to the lowest limit. A great deal of the ore obtained from the upper levels could be dropped down winzes by balance cages, as is done in working inclined coal seams. In the Niddrie Collieries, near Edinburgh, experience shows that it pays better to drop coal 100 yards down a staple pit than to wind it from an intermediate landing.

The best method of increasing the speed of winding appears to be to slightly increase the size of the engines, and to greatly increase the steam pressure. Small engines start easily, get up speed quickly, and can be stopped more conveniently. Consequently time is saved at the bottom and at the top of the pit. This is important, as it is on stopping and starting that time is lost. In many cases endeavours have been made to obtain a combination of swift winding and economy in fuel, by adopting variable cut-off gear. Compound engines for winding have been adopted, not only at Lake Superior, but also at Llanbradach Colliery near Cardiff, at the Treuil Collieries, Saint Etienne, at the Idria Mercury Mines, in Carniola, and at other places; but apart from economy in fuel, no particular advantage appears to have been gained.

(*b.*) *Enlarging Cages or Skips.* — The problem of overcoming the diminishing capacity of a deep shaft has been solved at Marchiennes by Mr. Alfred Soupart, in a remarkable manner. At this colliery there are two winding shafts, an elliptical one, 8 feet 6 inches by 9 feet 3 inches, and 3,000 feet deep, and a circular one, 10 feet in diameter, and 3,100 feet deep. These shafts eventually will be carried to a depth of 4,000 feet. Owing to the small diameter of the shafts, only single-tub decks could be used, and in order to be able to command a large output, it was decided to employ ten and twelve-deck cages, and thus to avoid running the engines at an abnormal working speed.

The cages with ten decks weigh 7,700 lbs., and the twelve-deck cages weigh 8,800 lbs. The dead weights with the empty tubs are 13,200 lbs. and 15,400 lbs. respectively. The loads amount to 11,000 and 13,200 lbs.

On the occasion of the visit of the Iron and Steel Institute to this colliery in 1894, the time occupied in changing was 120 seconds at No. 1 shaft, and only 80 seconds at No. 2. For winding, 120 seconds were required. The total time for each journey of a cage was thus four minutes at No. 1, and three and a-half minutes at No. 2.

In the Lake Superior copper mines, attempts have been made to overcome the difficulty by using larger skips. The Quincy Mine, for example, has introduced 7-ton skips, whilst formerly 2 and 3 ton skips were used. With heavier skips, there is, however, greater risk of breaking the ropes. In collieries, increasing the size of the tubs is not to be recommended. They become unwieldy, and are inconvenient to handle in the confined spaces underground.

The time occupied by a miner in descending to and ascending from his work is a matter for serious consideration. Before the application of winding machinery for raising men, and the invention of the man-engine, the means of access by steps, slides, and ladders were slow and exhausting.

With the increasing depth of mines, it becomes necessary to expedite the movements of the miners, and, with this object in view, there is a tendency to accelerate the speed of winding men in shafts. Careful experiments recently made by Mr. A. H. Stokes, H.M, Inspector of Mines, at a shaft 1,290 feet deep, show that, directly after starting away, the engineman endeavours quickly to gain speed, whereas the last two revolutions show his care in reducing the speed to a controllable velocity near the pit top. At one point in the shaft the men travel at the rate of 37 miles per hour. The speed of coal-winding in the same shaft is only a little faster. In cases where both shafts are available for the descent and ascent of men, the time occupied in lowering and raising them is considerably reduced, and it is highly desirable that both shafts should be supplied with equal facilities for the purpose.

In lowering large numbers of men who have to work at many different levels, the man-engine has been found convenient. Introduced in the Harz mines by Doerell, in 1833, in the form of two reciprocating rods, carrying small platforms, on which the men stand, the man-engine was adopted at the Tresavean Mine, in Cornwall, in 1842. Since that date it has been employed at various deep mines in Bohemia, Saxony, Westphalia, and Belgium, but at the present time it is being gradually replaced by the less costly cage.

(*c.*) *New Methods of Extraction.*—The employment of round ropes is limited to a certain depth, as a point is reached beyond which they will not support their own weight.

Theoretically taper ropes have no such limit. The use of ropes may, however, be dispensed with altogether. This was done at the Epinac Collieries, France, by Mr. Z. Blanchet. In the method of pneumatic hoisting, there successfully applied for ten years, there was fixed in the shaft a large tube with a piston from which was suspended a 9-deck cage carrying nine waggons, each holding half a ton of coal. By exhausting the air above the piston, the load was gradually forced up by the atmospheric pressure below it. While for descent, exhaustion was stopped and air allowed to pass upon the top of the piston. Three trucks were removed from the cage at a time by means of three double doors provided in the tube both at the top and the bottom. The Hottinguer shaft, where this method was applied, was 1,980 feet deep, and the tube was 5 feet 3 inches in diameter, made up of 485 rings of sheet iron 4 feet 4 inches high and $\frac{5}{16}$ inch thick, riveted together. The total weight of the rings was 418 tons, and the speed of the winding was 1,200 feet per minute. Unfortunately no coal was found, and the original idea of extracting 150,000 tons annually from a depth of 1,000 yards with two connected pipes, could not be carried out.

Ten years' experience proved that the method was a practical success, and if it had been possible to have installed two hoisting tubes in connection, the dead weights might have been made to counterbalance, and the power required would have merely been that necessary to overcome the weight of the useful load. While obviating the dangers due to the use of winding ropes, and improving the ventilation of the mine, the pneumatic method, though necessitating great expense in installation, must be looked to as the future method of winding when mines reach such depths as to render wire-ropes useless.

The idea of pneumatic hoisting is not altogether novel, for reference to the records of the Patent-office shows that quaint proposals with this object in view were patented in 1845 by J. Knowles and A. B. Woodcock, and in 1846 by G. H. Bovill and R. Griffiths.

With the object of increasing the shaft capacity almost indefinitely by devising a system in which several skips can occupy the shaft at the same time, it has frequently been proposed to wind in shafts by means of endless-chain bucket elevators, in a manner resembling endless rope haulage in levels. The method was in use in the Harz before the invention of the wire rope, and was tried in the middle of this century in this country, notably, at a colliery near Liverpool, for winding from a shaft 360 feet deep. On an iron pit frame there was placed a mechanically-driven axle, at each end of which there was a vertical sprocket wheel. At the bottom of the shaft the chain passed over similar wheels. The two chains were connected at every 18 feet by cross-bars, with hooks in the middle to which the tubs were attached.

An endless elevator was used in 1875 at a Saxon lignite mine; but, owing to the moisture in the coal, the buckets would not discharge automatically, and the arrangement was discarded.

Hoisting, by means of reciprocating rods, like those of the man-engine, has also been tried. The idea is not a new one; for it was, according to F. E. Bruckmann,* actually applied at Falun, in Sweden, as far back as 1694, by Christian Polhammer. A similar arrangement was devised by Hubert Sarton, a Belgian watchmaker, in 1776. In both methods an endless chain was used for lowering, whilst for raising, Polhammer had two reciprocating rods, with hooks to which the buckets were hung, whilst Sarton intended to use only one rod. The idea was revived in 1849 by Méhu, and carried into practice at Anzin for raising coals, and at the same time as a man-engine. The arrangement was very cumbersome, and after the inventor's death it was discarded. The method was also used with unfortunate results at Ronchamp Colliery, where no less than 1,500 yards of shaft and inclines were equipped with a complicated system of moving rods, slides, and counterpoises.

2.—The Increase in Pressure.

As mines become deeper, the pressure of the strata will increase, and heavier timbering will perhaps be required. No increase of timbering due to the depth has, however, yet been observed. Nevertheless, existing methods of timbering may in the future require modification. This has already been the case at the Comstock mines in Nevada, which were undoubtedly the best timbered in the world. There the old post and lintel system was replaced by the square set system, introduced in 1860 by Philip Deidesheimer. Although of great service in its day, and even now in general use in the Lake Superior iron-ore mines, the latter system is likely to become less useful in the future, mainly owing to the difficulty of obtaining timbers 24 inches by 28 inches. Most California miners use very heavy timbers in large stopes, mostly round, and often 30 inches in diameter. With the use of these immense logs, filling has been neglected to the detriment of the mines. In view of the increasing scarcity of large timber, we may expect that, in the future of deep mining, methods based upon the use of bearing arches of iron and steel, or of rock and masonry, will take the place of timber in mining deposits of large size.

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* "Magnalia Dei in Locis subterraneis." Brunswick, 1727.

The effect of the increase of atmospheric pressure on the men does not require serious consideration. Experience shows that men can work at a depth of 50 feet in water, that is, at a pressure of 37½ lbs. to the square inch, which is equivalent to a mine-depth of much more than 20,000 feet below sea level. On the other hand, the effect on machinery driven by compressed air is to diminish the efficiency, the efficiency being inversely proportional to the barometric pressure.

3.—Increase in Temperature.

The most important element needing consideration in determining the limits of deep mining is the increase of temperature. As far back as the year 1664, observations on underground temperature were made by Athanasius Kircher; in 1740 Genssane found an increase of 1° Fah. per 50 feet in the mines of Alsace; and in 1803 Daubuisson found a somewhat greater increase in the mines of Saxony and France. In 1830 Reich cited 35 authors who had previously dealt with the subject of underground temperature. Between that date and 1858, researches were made in the Cornish mines by John Forbes, Were Fox, and W. Jory Henwood. In 1871, the Royal Coal Commission made a special inquiry into the subject, and in 1867 a committee of the British Association was appointed for the same purpose. Twenty-one elaborate reports have been presented, and the work is not yet complete.

The influence of seasonal changes of temperature extends downwards to a limited depth, which varies in different latitudes. This zone of invariable temperature is higher in the equatorial regions than in temperate ones. In this country no annual variation of temperature is shown at a depth of 70 feet, whilst a shaft at Yakutsk, in North Siberia, shows that the soil is permanently frozen to a depth of 700 feet. Below the zone of constant temperature, the temperature increases with the depth, even in frozen ground; the average rate of increase being thought to amount to 1° Fah. for every 50 or 60 feet of descent. Some of the results published differ widely from this average, and there can be no doubt that in many instances sufficient precautions have not been taken to secure accuracy. The accuracy of the results may be vitiated in boreholes by the heat generated by the percussion of the boring-tool, in mines by the generation of heat by local chemical action due to the decomposition of pyrites, or to decaying timber, and by convection of heat both by air and water. Again, in mines the temperature is increased by the presence of workmen and lights, by blasting or fire-setting, by the vicinity of hot springs, and by the compression the air undergoes in penetrating into the deeper workings. On the other hand, the temperature is lowered by the admission of air and water from the surface, and, it may be, by the vicinity of large masses of extremely cold water. These are some of the causes that may explain the irregularity of many recorded results.

Underground temperatures are most conveniently determined by the aid of boreholes filled with water; and it is desirable that the water should not be in motion. For the observations, thermometers must be employed, which on being drawn out of the borehole, should register the maximum temperature to which they have been subjected. In the deep borehole at Sperenberg, Dunker* employed an earth-thermometer, which gives its indications by the overflowing of the mercury, which takes place when the instrument in exposed to a higher temperature than that at which it was set. The construction of the thermometer is shown in Fig. 1. The stem is open at the top, and bent sideways. It is graduated from the top bent point downwards. Above the point is a small vessel, *e*, open at top and sealed at the bottom by a little mercury. This, as well as the stem, is surrounded by a glass cover with a side opening, by means of which the thermometer is brought in contact with the external air or water. In order to set the instrument, it is immersed in warm water, so that the mercury flows over from the stem into the sealed vessel *e*. The instrument is then inclined until the point is under mercury, and cooled to a temperature below that expected in the borehole. On lowering the instrument into the borehole, the increased temperature will cause some of the

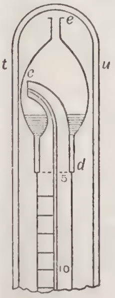

Fig. 1.

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* "Die Wärme im Innern der Erde." Stuttgart. 1896.

mercury to overflow at the point. Care must be taken to make the observation sometime after the cessation of boring, and the thermometer must remain for at least half an hour at the desired depth. Before it is withdrawn, it should be shaken, in order to remove any drops of mercury hanging from the point. When the instrument is drawn up, the glass cover is unscrewed, and the thermometer immersed in water at a lower temperature than that obtaining in the borehole. The temperature of the water is noted by means of a normal thermometer, and, at the same time, the number of degrees that are empty in the earth thermometer is also observed. The sum of the readings of the two thermometers gives the temperature of the borehole at the depth investigated. The reason of this is as follows:—The mercury, when in the borehole, extends to the point; and if the water in which the thermometers are placed is $x°$ cooler than the borehole, the mercury column is $x°$ shorter. These $x°$ must, therefore, be added to the temperature of the water to give the temperature of the borehole. In order to test the accuracy of the determination, warm water is added to the cold, until the mercury in the earth thermometer rises to the top. The normal thermometer should then give the temperature of the borehole.

If the latter method only is used for determining the temperature of the borehole, the scale on the earth thermometer may be dispensed with. In order to obtain accurate results, care must be taken to use perfectly pure mercury, prepared by distilling chemically the pure mercuric sulphide with iron filings, as slightest admixture of foreign metals favours the formation of breaks in the mercury column.

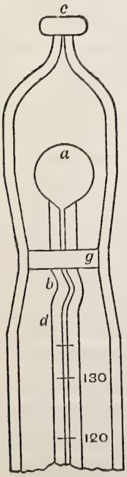

FIG. 2.

The best instrument for determining underground temperatures is Negretti and Zambra's inverted maximum thermometer. This (Fig. 2) has a bulb, *a*, at top, and a broad column of mercury graduated upwards. At *b*, in the stem, there is a sharp bend, which, together with the contraction of the mercury column at *d*, prevents the mercury from passing the bend except under pressure. The thermometer is enclosed in a hermetically sealed tube for protection against pressure, and is held in position by a cork, *g*. The method of using it is as follows:—With the bulb downwards the instrument is set by tapping on the palm of the hand till the contraction and the bulb is full of mercury. The thermometer is then placed, with the bulb still down, in water a little cooler than that in the borehole. If the instrument is now reversed all the mercury in the stem will run down to the lower end from which the gradations begin, and the top of the column will indicate the temperature of setting. In this position, the thermometer is then lowered into the borehole, and remains there for half an hour. As a precautionary measure, the thermometer is fitted into a hinged copper protecting case provided with holes.

In the borehole, the mercury expands, and a portion of the liquid is forced through the contraction, and subsequent cooling in hauling up will not cause any of it to return. The instrument must then be inclined, when the mercury in the stem will all unite into one column, which will run down to its place on again raising the bulb. The reading then gives the temperature of the borehole at the point in question. On lowering the instrument into the borehole, care must be taken to avoid concussion, inasmuch as some of the mercury might thereby be forced through the narrow portion, and give results 1° too high. Fig. 3 illustrates this thermometer as now made by Negretti and Zambra, under special instructions from Professor Everett, for the British Association Committee on Underground Temperature.

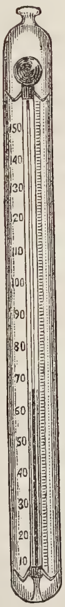

FIG. 3.

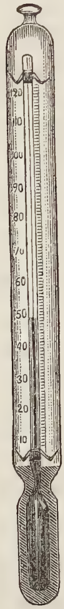

FIG. 4.

The same firm also manufacture a thermometer of very slow action, for taking direct earth temperatures. The bulb of this thermometer is shown, in Fig. 4, in its glass sheath, surrounded by a good non-conducting substance as suggested by Professor Everett. The thermometer is lowered down to the desired depth by a cord, and is allowed to remain a considerable time in the earth so as to acquire the existing temperature. It is then quickly withdrawn, and the reading noted, the non-conductor around the bulb preventing any rapid change taking place, so that an accurate reading may be obtained.

Determinations are best made during the progress of a borehole, by preparing at the bottom of the hole an isolated water column by the aid of an indiarubber plug. The form of plug designed by Dunker consists of a bag of stout indiarubber, 0·35 inch thick, filled with water, and pressed between two wooden discs, the upper of which is connected with the boring rods, whilst the thermometer is fixed to the lower one. Rotation of the rods in one direction screws the discs nearer together, and rotation in the other direction forces them apart. The indiarubber ball can thus be made to swell out and plug the bore when the desired depth has been reached, and can be reduced to the original size for raising or lowering. The necessity of adopting some such means of preventing the circulation of water in the borehole is apparent. Indeed, many of the published observations have shown so palpably the existence of convection as to render them useless.

The accompanying Table, compiled by Professor Everett, shows in concise form the results of underground temperature determinations collected by the British Association Committee up to 1882.

On comparing the results we notice that the Calumet and Hecla surpasses all other deep mines or boreholes, so far as our present records extend, in slowness of increase. In this case, however, the coolness of the rock is undoubtedly due to the proximity of the cold waters of Lake Superior. On the other hand, the Comstock results are abnormal, owing to the fact that the surrounding rock is heated from the lode probably by volcanic action. Immense volumes of hot water formed an obstacle to deep mining, and there is no doubt that this water is the vehicle of heat.

At the Calumet and Hecla Copper Mine the rock-temperature observations were made at various depths, with the aid of slow registering Negretti and Zambra thermometers placed in boreholes drilled slightly upwards to a depth of 10 feet, and plugged with wood and clay. In these holes the thermometers were left from one to three months. The highest rock-temperature obtained at a depth of 4,580 feet was 79° Fahr., whilst the rock-temperature at a depth of 105 feet was 59° Fahr. The difference of temperature in the column of 4,475 feet of rock is thus 20°, the increase averaging 1° for 223·7 feet. The average annual temperature of the air at the Calumet and Hecla Mine is 48° Fahr., and that of the air at the bottom of the shaft is 72° Fahr.

	Depth in Feet.	Increase in Temperature ft. for 1° Fahr.
Bootle Waterworks, Liverpool	1,392	130
Przibram Silver Mines, Bohemia	1,900	126
St. Gothard Tunnel	5,578	82
Mont Cenis Tunnel	5,280	79
Talargoch Lead Mine, Flintshire	1,041	80
Nook Colliery, Manchester	1,050	79
Bredbury Colliery, Manchester	1,020	78½
Ashton Moss Colliery, Manchester ..	2,790	77
Astley Colliery, Dukinfield	2,700	72
Schemnitz Mines, Hungary	1,368	74
Scarle Boring, Lincolnshire	2,000	69
Manegaon Boring, India............	310	68
Pontypridd Colliery, South Wales ..	855	76
Kingswood Colliery, Bristol	1,769	68
Radstock Colliery, Bath............	620	62
Grenelle Well, Paris	1,312	57
St. André Well, Paris	830	56
Military School Well, Paris	568	56
Kentish-town Well, London........	1,100	55
Rose Bridge Colliery, Wigan	2,445	54
Yakoutsk, Siberia	540	52
Sperenberg Borehole, Berlin	3,492	51½
Seraing Collieries, Belgium	1,657	50
Monkwearmouth Colliery, Durham ..	1,584	70
South Hetton Colliery, Durham	1,929	57½
Boldon Colliery, Durham	1,514	49
Whitehaven Collieries, Cumberland..	1,250	45
Kirkland Neuk Bore, Glasgow	354	53
Anzin Collieries, France	658	47
Carrickfergus Salt Mine............	570	40
Slitt Lead Mine, Weardale	660	34

The mean increase deduced from these results is 1° Fahr. in 64 feet.

Since that date numerous other important observations have been made, some of the results being as follows:—

	Depth in feet.	Increase in temp. ft. for 1° F.	Observer.
Calumet & Hecla, Lake Superior....................	4,580	223·7	Agassiz
Rand Victoria borehole, Transvaal................	2,500	82	Hamilton Smith
Port Jackson borehole, New South Wales	2,929	80	E. David and E. F. Pittman
Wheeling oil well, West Virginia....................	4,462	71·8	Halloch
Dolcoath mine, Cornwall...	2,124	70	Josiah Thomas
Schladebach borehole, Prussia	5,734	65	Huyessen
Paruschowitz borehole, Upper Silesia	6,573	62·1	Koebrich
Comstock lode, Nevada ...	2,230	33	G. F. Becker

Temperature observations, made with great care by Mr. H. A. Wheeler at other mines in the Lake Superior region, in 1886, gave the following results, which differ considerably from those obtained at Calumet and Hecla Mine:—

Mine.	Depth in Feet.	Increase in Temperature Ft. for 1° Fahr.
Atlantic	907	99·5
Central	1,950	101·0
Conglomerate ..	617	95·0
Osceola	996	76·5
Tamarack	2,240	110·7
Quincy	1,931	122·0

The mean increase is 1° Fahr. in 100·8 feet, or, omitting the Tamarack results, which were hardly trustworthy, as the stations were too close to active mining operations, 1° Fahr. in 99 feet. The variations among the different mines are very striking, the mines nearest to the shore of Lake Superior showing the lowest increase, and those farthest away showing the highest.

The deepest borehole yet made is that put down by the Prussian Government at Paruschowitz, near Rybnik, in Upper Silesia. The boring was begun on 26th January, 1892, and was finished on 17th May, 1893, after having attained a depth of 6,572·71 feet. The total cost of the borehole, which was put down to search for coal, was £3,761, and the increase of temperature was 1° Fahr. for 62·1 feet.

In the Schladebach borehole, 387 temperature determinations were made. These are of special importance, as they were taken at 58 points at equal distances down to the enormous depth of 5,734 feet. These results, like those at Sperenberg borehole and at Rose Bridge Colliery, which I have plotted in Fig. 5, are entitled to special weight, not only on account of the great depth, but also of the elaborate means employed to exclude convection.

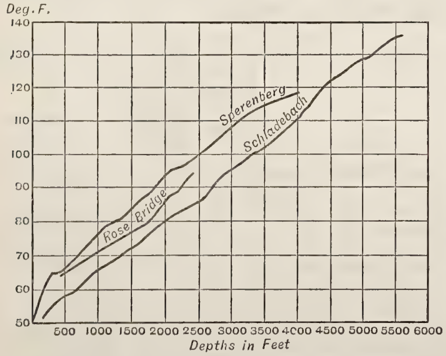

FIG. 5.

Professor Hull has offered a geological explanation of the discrepancy of the results obtained in several localities. Strata of various rocks with different conducting powers offer more resistance to the transmission of heat in a direction across, than in that parallel to their planes of bedding. Thus highly-inclined strata, such as those at Dukinfield (where the thermometric gradient was 72 feet per 1° Fahr.), furnish a path by which internal heat can travel obliquely upwards and outwards; whilst deep-seated horizontal strata, like those at the neighbouring Rose Bridge Colliery (where the thermometer gradient was 54 feet per 1° Fahr.) offer a succession of resisting surfaces to the upward passage of internal heat. It follows that in those districts where the strata are highly inclined (at angles varying from 30° to 60°) the underground temperature will be lower than in the case of those where the strata are nearly horizontal.

In considering the temperature it must not be forgotten that much depends on the degree of humidity. The increase of temperature tends to render the air capable of taking up more moisture, and consequently moisture is absorbed from rocks, coal dust, &c. If the air of the mine is sufficiently dry to admit of free evaporation from the bodies of the workmen, a considerably higher temperature could be endured than in an atmosphere having the ordinary humidity of a mine. On the other hand, in certain circumstances the mine may become very dry and dusty, and in collieries dangers would arise from the explosive character of dry coal dust. The only way to prevent the dust from becoming dry is to saturate the air with moisture.

4.—THE INCREASE IN MINING COSTS.

In working mines at very great depths, the cost of mining must undoubtedly increase. The increased cost would be due chiefly to the expenses connected with winding, pumping, and ventilation. Mr. J. H. Hammond calculates, however, that in the Witwatersrand, even in present conditions as to cost of labour and supplies, the extra costs of deep level mining to a depth of 5,000 feet should not exceed 5s. per ton. Dr. Becker, too, points out that the outlay on the deep mines should be economised by sinking relatively few but capacious shafts. To sink and equip a shaft 3,000 feet deep will cost about £100,000 more than to sink and equip one 1,000 feet deep. This expense is equivalent to an annual charge of 3½d. per ton on the quantity of ore requisite to supply a 200-stamp battery. It follows, therefore, that for mines worked on a large scale the increase of expense due to depth alone, in favourable conditions, is insignificant. Indeed, experience so far shows that, as the Rand mines are becoming deeper, improved machinery is coming into use, and there results an appreciable reduction in working costs, as will be seen from the following statistics :—

Year.	Stamps at work.	Working cost per ton.
1894....................	2,273	38s. 10d.
1895....................	2,546	33s. 3d.
1896 (first half)	2,890	32s. 10d.

An admirable instance of the economical results achieved in a deep mine is afforded by the Atlantic Copper Mine, Lake Superior. The copper-bearing rock lies at an average depth of 1,800 feet below the surface. The rock is broken down with explosives, sent to surface, crushed, hand-sorted, carried to the dressing floors, passed through stamps, thence through jigging-machines and over slime tables. Finally, the concentrates are conveyed to the smelting works. This complicated series of operations was carried on at a profit, although the ore yielded but ¾ of a cent. of copper, and only 5d. per lb. was obtained for the refined metal. In other words, the operations were remunerative when the company received but 6s. 6½d. for each ton of copper-bearing rock treated.

An analysis of the accounts of the Tamarack Mine has been published by Mr. A. C. Lane.* This is practically the deepest mine in the world, for ore is being mined at a depth of 4,450 feet from the surface; whilst at the Calumet and Hecla Mine, where the shaft is deeper, no ore is being extracted below 3,300 feet. The total running expenses (including cost of rock drills, fuel, other underground expenses, surface expenses, and stamping per ton raised) at the Tamarack Mine are shown in the following Table.

The figures show that the effect of increasing depth has been counterbalanced by that of increased output, and of improved machinery.

Year.	Average depth.	Cost per Ton.
	Feet.	s. d.
1894..	3,100	10 3
1893..........	3,000	9 10½
1892..........	2,900	9 2½
1891..........	2,800	10 8
1890..........	2,700	12 8
1889..........	2,600	12 6
1888..........	2,500	11 10½
1887..........	2,400	12 6
1886..........	2,300	12 6½

The increase of temperature has a serious effect on the amount of work men can do. In the South Staffordshire collieries, where owing to spontaneous combustion, working-places sometimes become abnormally hot, experience shows that the men cannot work such long hours, and moreover, they usually have to be paid extra, the costs being raised quite 12 per cent. This increased cost would be counterbalanced by the higher price which will be realised when coal is mined throughout the country from depths over 3,000 feet. As the shallow seams become exhausted, the rate of production will decline, and if the demand continues, the selling price must undoubtedly increase.

The cost of drainage in deep mines is not likely to be appreciably greater than in those of moderate depth. It has been proved that in most Cornish mines the volume of water encountered does not materially increase, beyond a certain point, with increased depth. The comparatively shallow workings intercept most of the water, leaving only a smaller and practically a fixed quantity to be dealt with in the sump. This is notably the case at Dolcoath and other deep mines. At Levant Mine, where the deeper workings are carried for nearly three-quarters of a mile from the cliff away underneath the sea, water is met with in very slight quantities. Again, on the Witwatersrand there appear to be no deep-seated springs, and all the water encountered underground comes from the surface. In the Lake Superior region, the water in some of the deep mines has been found to be a source of annoyance and expense. At the bottom of the Red Jacket shaft, the water met with is found to be highly mineralised. According to Mr. A. C. Lane, it is a strong solution of calcium chloride and other salts, which rots the miners' clothes and produces boils. Owing to this fact, it has been found necessary to increase the men's wages.

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* "Mineral Industry," New York, Vol. iv., page 768.

Another possible source of increased expense in deep mines is the necessity of surveying operations. The importance of accurate mine plans is now generally recognised. The expense of the necessary surveys is, however, not likely to add seriously to the cost of mining at great depths. At the present time the cost is trifling. In Westphalia, for example, where the mine plans are laid down with excessive accuracy and the mines are fairly deep, the annual expenditure on plans and surveys is calculated to be 8¾d. for every 100 tons of coal raised. Some difficulty might be expected in connecting the underground and surface surveys by an optical method in very deep shafts, but fortunately an ingenious method* with swinging plummets has been devised by Professor M. Schmidt, which has been applied with great success in the Bohemian and Saxon mines to a depth of 2,300 feet. There is no doubt that accurate results can be obtained with this method at far greater depths.

C.—Prospective Yield of Deep Mines.

In calculations having reference to the duration of our coal supply, the limit of depth adopted by Professor Hull in 1860, and by the Royal Coal Commissioners in 1870, in the estimates of the workable quantity of coal, was 4,000 feet; and a careful consideration of the facts that have come to our knowledge since that date tends to confirm the accuracy of this view. Mr. H. W Hughes, the manager of Sandwell Park Colliery, and the author of the standard text-book on coal-mining, is, however, inclined to assume a considerably lower limit for the thicker seams of coal. He informs me that he is quite ready to admit that mining in seams up to 6 or 7 feet in thickness could readily be carried on up to a depth of 4,000 feet. The temperature of the strata will most seriously affect the operation of working, but as ventilating appliances become more powerful, enormous volumes of air can readily be circulated throughout the working places, thus materially reducing the temperature and increasing the comfort of the men. There seems no reason why the air introduced should not be cooled at some point underground. This would, of course, increase the cost; but the benefits resulting should compensate for the additional outlay. It would not be advisable to reduce the temperature much in the downcast shaft, especially if water were present, owing to the formation of ice, which would affect the convenience of working. The reduction of temperature should take place some distance from the bottom of the shaft. In thick seams, especially those from 15 to 30 feet, the limit of depth would be considerably less than 4,000 feet. Owing to the impracticability of completely stowing or filling horizontal thick seams, and the consequent necessity of supporting the roof with timber, and of finally allowing it to break down instead of settling, as it would if the workings were packed, the effect of pressure becomes a very serious matter. Indeed, at 2,000 feet the difficulties are very considerable, and the conditions at 3,000 feet would probably be such as to render working impracticable.

Turning from coal seams to consider the prospects of deep mining of mineral deposits, we find that public opinion has greatly changed. Formerly the view was generally held that veins became richer with increasing depth. Now rumours prejudicial to deep level gold mining in South Africa and elsewhere have been in circulation.

For a long time there appears to have been an impression that mineral veins are productive to a certain depth only, and that all below is valueless. Statements relative to the disappearance of veins in depth must be received with caution, since, had the workings been continued, the vein would probably have again been found, and have again become productive. The examples of depths obtained in vein mining cited earlier in this paper, show that there is every reason to believe that true veins extend to depths to which the miner will be unable to follow them.

The question, however, arises: Will mineral veins be productive at great depths? Werner, the founder of modern geology, stated in 1791 that every miner was aware that veins disappeared in depth. This view, was, however, opposed by Schmidt in 1827; and even in Werner's time the fact that the lower end of thick veins was not reached by the deepest mines was shown by the 500-fathom shaft at Kuttenberg, in Bohemia, and by the Heilige Geist shaft at Kitzbühl, in Tirol, which in the 57 years between 1540 and 1597 was sunk to a depth of 2,900 feet always in ore.

With regard to the productiveness of mineral veins at great depths, suffice it to say that the Dolcoath lode is as rich at the deepest point reached as it ever was; that rich discoveries of ore have been made at the 2,330-foot level of the Samson Mine at St. Andreasberg in the Harz; that the richness of the Przibram mines has increased rather than diminished at depths below 3,000 feet; and that at the Australian gold mines there are in Victoria mines extracting with profit gold ore from depths of 2,500 to 3,300 feet.

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* Brough, "Treatise on Mine Surveying," 5th Edition. 1896, p. 204.

On the other hand, it cannot fairly be supposed that the richness of mineral veins invariably increases with depth. This belief is held by many practical miners. Carried to its logical extreme, it suggests that eventually the original source of the metal will be reached. In support of this wild notion, even the unexplained terrestrial density has been quoted as a favourable argument. Its origin seems to have sprung from the once generally accepted theory that mineral veins are formed from the deposits of heated rising waters.

In New Zealand the recent discovery of auriferous lodes, at deeper levels than those hitherto worked, has given an impulse to mining, as these discoveries have shown that new lodes, containing ore of a payable character, will be found at great depths to take the place of those carried down from the surface which have cut out. Many mines, which have been given up as valueless, will now be tested to far greater depths than heretofore, and by judicious management they may yet be made to yield returns which will fully compensate the owners for their outlay.

We now come to a consideration of the prospects of deep mining in South Africa There, as is well-known, the gold of the Witwatersrand is obtained not from mineral veins, but entirely from beds of conglomerate, known as *banket*, composed mainly of quartz pebbles embedded in an auriferous matrix consisting originally of sand, but now completely cemented to an almost homogeneous material by a later deposition of quartz. The average total yield of the conglomerate stamped is 13·16 dwt. of fine gold per ton. The output of gold from the Witwatersrand has risen from 23,000 ozs. in 1887 to 2,277,637 ozs. in 1895, and the Transvaal now produces one-fifth of the world's supply.

As the bedded character of the banket deposits became known, and as the persistency in depth and the uniformity in the gold contents became established by deep boreholes, companies were organised to work the deep-seated portions of the beds. Although, near the surface, the dip is steep, fortunately, as the reef goes down, a very important flattening takes place, so that the future of the Transvaal gold industry is assured. It is true that as yet there is but little positive knowledge as to the maintenance of the ore value at great depths. We have, however, in the Robinson Deep shaft which struck the reef at a depth of 1,806 feet; in the Rand Victoria borehole, which, at 4,100 feet from the outcrop, struck the reef at 2,343 feet, 13 inches wide, assaying 1 oz. 3 dwt. per ton; in the Bezuidenville borehole, which, at 5,800 feet from the outcrop, struck the reef, dipping 29° at a depth of 3,251 feet; in the Tracey-English borehole, which, at 4,100 feet from the outcrop, struck the reef, dipping 30° at a depth of 2,397 feet; and in the Durban Roodeport Deep, where the reef was recently intersected at a depth of 1,300 feet, 8 inches in width, and assaying 3 oz. 2 dwt. per ton, sufficient evidence that the banket extends some 6,000 feet south of the outcrop. Besides this, there is the fact that the banket has already been struck by 16 shafts all along a line of 12 miles. Moreover, a careful study of the assay results shows that the variations in ore value along the dip are similar in character to those along the line of the reef, richer and poorer areas being irregularly distributed. No indication is given of the existence of a progressive impoverishment of the bed. The erroneous idea that the Transvaal mines become poorer as the depth increases is apparently due to the decreased percentage of gold in the ore crushed. This decrease is obviously explained by the fact that the decrease in working expenses has rendered it possible to treat the poorer ores that formerly were laid aside.

The Table (p. 72) (for which the *Statist* is my authority) gives the latest information regarding the deep-level companies, arranged in order from west to east.

From our knowledge of the geology of other districts, the persistency and uniformity of the Transvaal auriferous conglomerates in depth is not surprising. In the Westphalian coalfield, for example, there is a bed of conglomerate intercalated between two seams of coal, traversing the whole basin. Again, at Saarbrücken a similar bed of conglomerate serves as index-bed for the whole coalfield. These conglomerates are uniform in texture and composition throughout. Judging by analogy, it is evident, therefore, that, below the depth to which atmospheric agencies penetrate, no further alteration in the character of the Witwatersrand ores is to be expected. There is no ground for fearing uncontrollable

WITWATERSRAND DEEP-LEVEL MINES.

Company.	N. boundary: Distance from outcrop. Feet.	Dip degrees.	Depth to reef.
Langlaagte Deep	1,500	35	Shaft No. 1 struck reef July, 1896, at 1,165 feet; No. 2 at 817 feet, in January, 1896.
Crown Deep	1,300	30	Shaft No. 1 struck reef, December, 1894, at 984 feet; No. 2, March, 1896, at 1,150 feet.
Robinson Deep	2,700	30	Reef expected at No. 1 shaft at depth of 2,300 feet; No. 2 struck south reef, July, 1896, at 1,806 feet, and main reef, September, 1896, at 1,877 feet.
Nourse Deep	500	40	No. 1 struck reef, July, 1894, at 917 feet; No 2, March, 1895, at 1,003 feet.
Jumpers Deep	700	28	No. 1 struck reef, March, 1896, at 901 feet; at No. 2 reef expected at 1,350 feet.
Jupiter	3,700	—	Reef expected at 2,500 to 3,000 feet.
Geldenhuis Deep	1,400	27	No. 1 struck reef, December, 1894, at 565 feet.
Simmer and Jack West	4,500	—	Reef expected at 2,500 to 3,000 feet.
Simmer and Jack	0	26	Outcrop shafts, and three first series deep-level shafts developing reef; three second series deep-level shafts being sunk expect to reach reefs at 2,600 to 3,000 feet.
Rose Deep	1,700	30	No. 1 struck reef, May, 1895, at 910 feet; No. 2, March, 1895, at 714 feet.
Glen Deep	1,600	35	No. 1 struck reef, September, 1896, at 920 feet.
Simmer and Jack East	4,000	—	Reef expected at 2,000 to 3,000 feet.
Knight's Deep	2,000	—	Reef expected at 1,300 to 1,500 feet.
Knight Central	4,800	—	Reef expected at 2,800 to 3,100 feet.

quantities of water or a very rapid increase in temperature. There are, therefore, no reasons why mining on the Witwatersrand should not be carried on at a depth of 4,000 feet, and Dr. G. F. Becker, the distinguished American mining geologist, who has recently carefully studied the question, has arrived at the conclusion that in favourable industrial conditions the expense should not exceed the present cost at 500 feet.

In view of the depressed condition of Cornish mining at the present time, the subject of mining mineral veins at great depths is one of considerable importance in this country. I am glad, therefore, to be able to publish the following statement of the views held by my friend, Mr. William Thomas, the Secretary of the Mining Institute of Cornwall, and Lecturer on Mining at the Camborne School of Mines, who has long devoted special attention to the subject.

That deep mining in Cornwall is well within the range of possibility, is shown by the energetic action taken of late by the owners of the Dolcoath Mine, at present, and for some years past, the deepest, as well as the most productive, of the Cornish tin mines. The deepest of the existing inclined shafts at Dolcoath is the new Sump shaft on which the principal Cornish pumping engine is erected. This shaft is now being sunk by two rock-drills below the 440 fathom level, and, allowing for the depth of the adit (about 30 fathoms), has reached an inclined depth of 480 fathoms or a vertical depth of over 2,400 feet. Towards the end of 1895 a new vertical shaft of 18 feet diameter was commenced, and is expected to intersect the main lode at a depth of about 3,000 feet. There are four rock-drills employed in sinking this shaft.

At the Basset mines, too, a new vertical shaft, 16 feet 6 inches diameter, is being sunk at the present time. Both the Dolcoath and the Basset new vertical shafts are to be fitted with the best and most efficient winding and pumping machinery obtainable.

For a long period the output in many Cornish mines has been restricted, mainly because of inadequate tramming and shaft accommodation. True, in some of the smaller mines, the available reserves were too limited in quantity to warrant any outlay in the construction of better tram roads, or new shafts; but this does not apply to such mines as Dolcoath and the chief mines on the Flat Lode. At the Basset mines, and also at Wheal Grenville, there are wonderful possibilities (or, perhaps, *probabilities* is a better word to use) of deep mining along the dip of the Flat Lode. This lode dips south at an angle of 35° or 40° from the horizontal, so that vertical shafts can be made to open up vast extents of lode which, if the shafts are judiciously placed, can be worked at very low costs.

There are no difficulties peculiar to Cornwall, in the way of deep mining. If pumping, winding, and ventilation can be satisfactorily dealt with in the deep copper mines of Lake Superior, in the deep gold mines of Victoria, and in the deep levels of the Witwatersrand, there is nothing to prevent the same measure of success being attained in Cornwall.

DISCUSSION.

The CHAIRMAN said he thought on most points in this elaborate paper there would be a general agreement, but on a few perhaps there might be a difference of opinion. He did not think the question of increase of temperature was one of practical importance, for wherever there were minerals worth getting, it would be quite possible to make the mines fairly comfortable. In the case of hoisting vertically from enormous depths, there would ultimately be a limit, though it had not yet been reached. But here again there were modes of meeting the difficulty by division of the lift, and the transmission of power by means of electricity might become of enormous importance in this connection. Possibly the old Cornish system of catching the lode and following it, and hoisting up the incline, might be reverted to in connection with electrical methods.

Mr. RICHARD P. ROTHWELL said in the Lake Superior district they had attained a depth of nearly 5,000 feet, and so far there had been no inconvenience experienced from any of the causes referred to. The temperature had not increased to an inconvenient degree, the water was notably lighter in deep mines than in shallow, and there was no practical difficulty in hoisting when using taper ropes and lifting heavy loads. As every one knew, there was a practical limit to the use of wire ropes, even when tapered, for after a time the rope would be so heavy that the weight would equal the working load, so that it would only carry itself, but, as the Chairman had suggested, that difficulty could be overcome by the use of electricity, or by other means. There was no practical difficulty in changing hoists, even in motion, in a shaft, so that there would be no real difficulty in getting down to any depth where good ore could be found. The question of the richness of ores at great depths was much more serious. He did not believe in the richness increasing with the depth, but the contrary, for in his experience, ores rather got poorer. Of course, that was not universal, nor was it the popular view. There was no practical difficulty from increased cost, and, hitherto, improvements in mechanical appliances had more than balanced the increased costs due to greater depth. In some cases, of course, the increase of temperature was a serious difficulty. In the Comstock district it was sometimes almost impossible to work, and the men had to be changed every twenty minutes, which, of course, made the working very expensive. But that was in a volcanic district. In some parts of the mine they had to line the drifts with wooden staves to enable the men to work in them at all.

Mr. H. W. HUGHES said he always felt somewhat of a stranger on such occasions, representing as he did the coal mining section, while most of his friends were metal miners; and the discussion usually turned chiefly on points affecting metal mines. This was only natural, because most men who made money were associated with metal mines. The chief points to be feared with deep mining were increase of temperature and cost. He had been in many metal mines, and thought that a really perfect system of ventilation was practically non-existent in them; he meant such a system as was necessary in a modern coal mine, where there was a large per-centage of gas and dust. As the Chairman had said, where the ore was worth working, mechanical science found a way of going down any depth to get it. He was connected with the mine working probably the deepest thick coal in the world. Up to 6 or 7 feet thick there was no difficulty, but when they came to work seams of from 15 to 30, or even 45, feet thick, it was quite a different story. The pressure then became very considerable, and as the coal was peculiarly liable to spontaneous combustion, and the pressure cracked the coal, and produced a certain amount of small, there was great difficulty in keeping the main roadways and workings free from fire. This had a serious effect on the working cost. One of the collieries with which he was connected had a fire, and within the last three months the money expended in consequence on wages alone, apart from materials, had amounted to 3d. a ton. Now 3d. a ton in a metal mine was comparatively small, because they generally raised a small amount of high value; but in a coal mine, which last month raised 57,000 tons, where the working cost was 2s. 10d., and the selling price only 4s. 10¼d., 3d. a ton was a serious matter. Where the margin of profit was so small every increase in the cost was important, and they soon passed the paying stage. He therefore thought that 4,000 feet would prove somewhere about the limit for coal mining unless customers were willing to pay a higher price. There was a certain amount of expense which went on whether the colliery was worked or no, and if the output were decreased, the working cost increased, and very soon there was no margin of profit left.

Mr. W. Whittaker, F.R.S., being called on, said he had very little to say, his business being only to find the coal mines, leaving it to other people to work them. He believed much coal would yet be found in the South of England at no great depth, where it would pay well to work it, and there was also very fair room for expansion in the present collieries. No doubt the available area for working coal there would be extended, although at present the only positive discovery was at Dover.

Mr. A. G. Charleton said he had been very much interested by the paper and the illustrations, some of which he thought he could recognise, having been in the workings portrayed. There was a system of timbering carried out in Australia not mentioned in the paper, which deserved to be better known. It was called the pigstye set, and it came in very useful in large excavations, where there was heavy ground to support. In one instance he had to cut down an underlie shaft, and carry it down through old ground, where there was about 30 feet of old stuff standing about the old timbering, and by this means he was able to support a weight of ground which would have been very difficult to deal with by props. In some cases there were loose masses of stone, weighing several hundred tons. This system consisted of a number of props crossing one another, arranged in squares, filled in in the centre with large blocks of stone. Another system of timbering which he had employed successfully in deep shafts was known as box timbering. The great advantage of that was the rapidity with which you could get a shaft down. With rock drills, and the aid of this system, they had driven a shaft at an average rate of 70 feet a month through hard syenite.

Mr. Thomas Rickard thought this paper was evidently intended to bear strongly on mining in South Africa, but it seemed to him that the conditions there were so different to those existing elsewhere that the experience of the Comstock or Lake Superior mines did not apply. In the calculation of the cost, a most important point, the sinking fund, had been omitted. The cost of mining in the Transvaal was 28s. a ton, and if that were all, there would always be a prospective profit; the returns had been generally about 12s. in excess of the cost, and it was said that the increased cost of mining to a depth of 5,000 feet would not be more than 5s., still leaving a balance of 7s. But that soon disappeared if you formed a sinking fund to replace the capital expended in opening out the mine, and, in fact, it required three or four times the amount. For a mine at Johannesburg capable of milling 1,000 tons a day, you would require about 400 claims, which would cost about £6,000 per claim, amounting at once to 2½ millions. It took nine years at the rate of 50 feet a month to sink shafts 500 feet, and it took at least three years to open out a mine on a scale sufficient to supply a mill treating 1,000 tons a day. If you reckoned compound interest at 10 per cent. you soon get to such a figure that the sinking fund would swallow up the whole value of the ore extracted. Under these circumstances he did not think it was right to place before the British public the results of mining where large masses were dealt with, as if they applied to Johannesburg. It had been stated complacently that there would be no difficulty with water, but at Johannesburg there were six or seven large issues of water at a depth of 1,100 feet below the surface. If the mines were opened out below that level, would not the water flow back into them? Having coal only half as good as at Cardiff, and about double the price, it appeared to him that the water question would be a very serious one. Again, there was the question of the interruption of the beds. If they were interrupted lengthwise in the strike, what right had they to suppose that they would not also be interrupted on the dip? The whole place was reticulated with large intrusive masses of rock. Were they to be exempt from the same derangements as they went down. If they got one of these all through, or following up a bed, the whole mine would have to be re-erected, which, at a depth of 5,000 feet, would be ruin. Deep mining at Johannesburg was a phase not yet begun, and it would not be for another ten years. Those who called 1,000 or 1,500 or 2,000 feet a deep mine, did not understand the question. When Johannesburg mining engineers spoke of deep mining they meant 5,000 feet, and there was not a self-respecting mining engineer who would lay out a mine, in which he had to deal with water, who would do otherwise than go to the deepest point and work upwards. If you proceeded in that way, you must reckon compound interest on the capital for at least 12 years before the mine was opened up. This was the main point; questions of temperature and the cost of extraction were of comparatively little moment.

Mr. Brough, in reply, said he was very glad that so many new points had been elicited in the discussion. The question of electrical transmission of power had escaped his notice, though it was so important that it ought to have had a section to itself. He had been obliged to omit a good deal in reading the paper, or Mr. Rickard would have seen that he was not much at variance with him. In dealing with the question of cost, however, he had purposely avoided all reference to a sinking fund, as he did not wish to deal with any concrete case, but with deep mining in the abstract. Incidentally it was necessary to mention South Africa, but he had endeavoured to preserve a perfectly judicial attitude. He would take this opportunity of thanking various friends who had favoured him with information, partly as to the depths of shafts, so that he hoped the Table would be valuable for reference.

The CHAIRMAN then proposed a vote of thanks to Mr. Brough, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

OYSTER CULTURE IN RELATION TO DISEASE.

A supplement of the Twenty-fourth Annual Report of the Local Government Board for the year 1894-5 contains a report by the medical officer of the Board, Dr. Thorne Thorne, on the cultivation and storage of oysters in relation to the occurrence of disease in man. The report itself is short, and of the nature of an introduction to the other material, which is given in appendixes.

The first appendix is a very elaborate report by Dr. H. T. Bulstrode on the conditions under which oysters, and certain other edible molluscs, are cultivated and stored along the coast of England and Wales. Supplementary to this is a report by Dr. Klein on his bacteriological researches; a report on the outbreak of typhoid fever in Connecticut; and some extracts from the proceedings of the Académie de Médicine of Paris, relating to the spread of disease through the agency of oysters.

Dr. Bulstrode visited the various places along the coast of the country where oysters are laid down for the purpose of storage or development. Many of these he found distinctly liable to sewage contamination, while others were free from any reasonable risk of such contamination. The safe and dangerous oyster layings are all specified in the report, so that it is really quite practicable for the public to assure themselves of the character of the oysters which they consume, if they will only take the trouble to ascertain the place from which they come. Probably also this report will have the wholesome effect of inducing the proprietors of the oyster layings specified as dangerous to take such steps as may remove future risk of sewage contamination. Dr. Bulstrode's report is very fully illustrated with maps and plans.

Dr. Klein, in his report on the bacteriological points which were raised in the course of the inquiry, says that he has found in abundance in oysters from tainted sources the well-known bacillus coli, which, though it must not be taken as proof positive of excremental pollution, since the bacillus itself is almost ubiquitous, yet when it is present in large quantities, it affords a very strong presumption indeed that excremental pollution is present. Dr. Klein, in one case, also detected the typhoid bacillus, which he states to have identified by all known tests.

The conclusion to be drawn from the report is that certainly oysters can convey the germs of disease, such conveyance being, it appears, of a purely mechanical kind; that the risk of any given sample of oysters containing such germs is extremely small; and that for any dangerous conditions to exist the oyster has to be consumed by a susceptible person. The co-existence, at one and the same time, of all these conditions is not likely to be of frequent occurrence. It is further to be noted that the report shows that with only ordinary precautions on the part of those supplying oysters to the market this risk, though very small, can be entirely abolished.

Correspondence.

ARTISTIC COPYRIGHT.

When the history of the Society of Arts, Manufactures, and Commerce shall come to be written and its benefits to the community of Art to be recorded, the codification of the law of copyright will hold high place—not that it gave all that was desired, but it was a great advance upon the way. Of the powerful committee, headed by the President of the Royal Academy of Arts in 1858–60, but few survive.

This committee sat for about two years, and it ended in a deputation to Lord Palmerston, that was introduced to the Premier by Sir Edwin Landseer, who explained the objects sought to be remedied, objects that I believe were embodied in a draft Act, that was handed over to the Hon. Spencer Walpole, who in a few days drafted the labours of a long time into the Act as it now stands.

At that time even the idea of international copyright was thought of. The Americans having profited largely by the adoption of English art, and moreover, Germany was just commencing to invade, not so much the English market, as that of English speaking peoples, a trade that has vastly increased since that period.

It seems strange that foreigners can claim protection under English law, when it is denied to them abroad, an inference that I would draw from the case of Geissendörfer *v.* Mendelssohn, tried a few days since at the Queen's Bench, showing the necessity of an international copyright in works of art, in a like manner with literature, for it is doubtful if plates, even illustrative of literature, have the same protection as type matter.

Of the necessity of international arrangement, we have abundant evidence in the reports of the Antwerp Congress, and of the one held at the Palais Bourbon and the Louvre, in 1878, under the presidency of M. Meisonnier and an international assembly of representatives.

To effect an international law, a congress of picked representatives would alone be able to deal with the question, and thus place works of art upon the same basis as literature. By works of art, I mean paintings, drawings, and maps to the exclusion of photographs from objects of nature, these not being intellectual efforts.

It is possible that a congress could be carried on by means of the post, soliciting answers to tabulated questions, an assembly finally confirming or repealing the same.

The issue of the Antwerp and Paris Congress can hardly be said to be encouraging. The Continental Art seems the most to desire protection, and it is quite possible that England, who has not taken the initiative, might be the cause of a most desirable consummation, probably under the presidency of the President of the Royal Academy.

JOHN LEIGHTON, F.S.A.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

DECEMBER 16.—"The Chamber Music of Purcell, Handel, and Bach." (With Illustrations on the original Instruments for which it was written.) By ARNOLD DOLMETSCH.

Papers for meetings after Christmas :—

"Children's Sight." By R. BRUDENELL CARTER, F.R.C.S.

"Light Railways." By EVERARD R. CALTHROP.

"Cycling—Historical and Practical." By GEORGE LACY HILLIER.

"A Half Century of Line Engraving, 1780-1830." By GEORGE CLULOW.

"Lithography as a Mode of Artistic Expression." By LEO McCULLOCH.

"The Artistic Treatment of Heraldry." By W. H. ST. JOHN HOPE, M.A.

"Dairy Produce and Milk Supply." By M. J. DUNSTAN, M.A., F.R.S.E.

"The Transmission of Power by Alternating Electric Currents." By W. B. ESSON, M.Inst.C.E.

"London Water Supply." By PERCY F. FRANKLAND, Ph.D., F.R.S.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 14....Imperial Institute, South Kensington, S.W., 8½ p.m. Hon. W. Pember Reeves, "The Hot Springs District of New Zealand."

British Architects, 9, Conduit-street, W., 8 p m. 1. Messrs. William C. Street and Max. Clarke, "Reports on the Second Series of Experiments on Brickwork conducted by the Science Standing Committee." 2. Professor Unwin (i.), "Reports on Lime, Cement, and Bricks used in the Experiments;" (ii.) "The Relationship between Form and Strength."

Camera Club, Charing-cross-road, W.C., 8¼ p.m, Mr. Bryan Hook, "A Talk about Birds."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. I. Zangwill, "The Drama as an Artistic Product."

Royal Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. Dr. Stevenson Macadam, "Safe and Unsafe Mineral Oils for Lighting and Heating."

TUESDAY, DEC. 15... Self-Propelled Traffic Association, Royal Institution, Liverpool, 8 p.m. Messrs. W. B. Cook and F. Willoughby, "A New Method of Utilising Canals for Traffic—with a special reference to the Canals of Lancashire and Yorkshire."

Statistical, in the Theatre of the United Service Institution, Whitehall, S.W., 5½ p.m. Rev. William D. Morrison, "The Interpretation of Criminal Statistics."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 12, Hanover-square, W., 8 p.m. Mr. Andrew Wybrandt-Penrose, "Some probable causes of trouble in Photo-engraving, with demonstrations of methods for their detection."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. G. Herbert Fowler, "Contributions to our Knowledge of the Plankton of the Faeroe Channel." 2. Mr. Oldfield Thomas, "On the Genera of Rodents; an attempt to bring up to date the current arrangement of the Order." 3. Dr. J. W. Gregory, "On *Lysechinus*, a new Genus of Plesiocidaroids from the Tyrolese Trias."

WEDNESDAY, DEC. 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Arnold Dolmetsch, "The Chamber Music of Purcell, Handel, and Bach."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Richard H. Curtis, "An Attempt to determine Velocity Equivalents of Wind-Forces estimated by Beaufort's Scale." 2. Mr. H. E. Leigh Canney, "The Winter Climate of Egypt."

Geological, Burlington-house, W., 8 p.m.

Microscopical, 20, Hanover-square, W., 8 p.m.

Institute of Architecture, Science, and Art (Dundee), 8 p.m. Mr. Alexander M'Gibbon, "A Gothic Renaissance."

THURSDAY, DEC. 17...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. L. A. Howard, "The Chalcididæ of the Island of Grenada." 2. Mr. W. C. Worsdell, "The Development of the Ovule of Christisonia, a Genus of the Orobancheæ."

Chemical, Burlington-house, W., 8 p.m. Messrs. Horace T. Brown, G. H. Morris, and W. H. Millar (i.), "The Experimental Methods employed in the Examination of the Products of Starch-hydrolysis;" (ii.) "The Specific Rotation of Maltose and of Soluble Starch;" (iii.) "The Relation of the Specific Rotatory and Cupric-reducing Powers of Starch-hydrolysis by Diastase."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. A. A. Kanthack, "The Bacteria which we Breath, Eat, and Drink."

Historical, 28, Jermyn-street, S.W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Captain E. H. Hills, "The Recent Solar Eclipse."

FRIDAY, DEC. 18...Junior Engineers, Westminster Palace Hotel, S.W., 8 p.m. Mr. P. W. McDougall, "Electric Central Station Working."

Queckett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Journal of the Society of Arts.

No. 2,300. Vol. XLV.

FRIDAY, DECEMBER 18, 1896.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 6 and 13, 1897, by CLINTON T. DENT, F.R.C.S., Past President of the Alpine Club, on "The Growth and Demolition of Mountains." The lectures will be fully illustrated with lantern slides and experiments. After a brief sketch of the growth of mountains, the following points will be discussed in the course:—The agencies which contribute to the demolition; wearing and weathering of rock; protective and destructive influence of glaciers; avalanches—the Altels avalanche in 1895—mountain falls—bursting of glacial lakes.

The lectures will commence at seven o'clock. Special tickets are required for these lectures, which can be obtained on application to the Secretary. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. The cards are now in course of issue, and it is desirable that members requiring them should apply at once.

Proceedings of the Society.

FIFTH ORDINARY MEETING.

Wednesday, December 16, 1896; Professor JOHN M. THOMSON, F.C.S., F.I.C., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Chart, Robert Masters, The Limes, Mitcham, Surrey.
Gahagan, Ronald Hayes, 30, Nepean-sea-road, Malabar-hill, Bombay.
Head, Jeremiah, 47, Victoria-street, S.W.
Johnstone, Capt. James H. L'Estrange, R.E., The Hangingshaw, Selkirk, N.B.
Letts, Charles, 8, Bartlett's-buildings, Holborn-circus, E.C.
Marsden, James, Grosvenor-house, 18, Grosvenor-road, S.W.
Penn, William Cooper, 15, Victoria-street, S.W.
Rovsing, Capt. Christian, M.C., B.A., care of the Siamese Legation, 23, Ashburn-place, S.W.

The following candidates were balloted for, and duly elected members of the Society:—

Crawford, Mrs. J. A., 9, Victoria-street, S.W.
Fearon, Thomas Laurence, 27, Guildhall street, Folkestone.
Hills, Arnold Frank, Monkhams, Woodford-green, Essex.
King, William Isaac, The Grange, Highgate, N.
Winter, George Bliss, South Indian Railway, Trichinopoly, India.

The paper read was—

THE CHAMBER MUSIC OF PURCELL, HANDEL, AND BACH.

By ARNOLD DOLMETSCH.

The chamber music of Purcell, Handel, and Bach represents the highest standard of that class of music during the last quarter of the seventeenth, and the first half of the eighteenth century. No great change happened during that period, either in the kind of instruments employed, or in the style of the music; but its beginning saw the viols, as a family of instruments, superseded by the violins, the viola da gamba alone surviving; and "modern music" may be considered to commence with the immediate successors of Handel and Bach, who saw the harpsichord go out of fashion and the pianoforte replace it.

The style of music did not change very materially from Purcell to Handel and Bach; of course, the compositions of these three great men are easily distinguishable; but the works of Purcell, in his riper years, are far nearer Bach than they are to the fancies for viols of Jenkins, or of Matthew Lock even, or the "Divisions on a Ground," of Christopher Simpson; and there is a great gulf between J. S. Bach and the very earliest efforts of Haydn, although the gulf was filled by a number of minor, very minor composers. The instruments chiefly employed during the period in question were: the viola da gamba (sole survivor of the viol family), the violin, the harpsichord, and the clavichord.

I purposely omit the wind instruments, of which I have no special knowledge. The violins of to-day are practically the same as those of Purcell's time, only that they sound more shrill on account of the great rise in pitch which has taken place since then.

But the viola da gamba, the harpsichord, and the clavichord have become entirely obsolete, or, I should say, they were entirely obsolete only a few years ago, for they are coming to life again.

The music written for these instruments, when performed now-a-days, is played upon the violoncello instead of the viola da gamba, and upon the pianoforte instead of the harpsichord and clavichord. Most people appear quite satisfied with that arrangement, they think the modern instruments so immeasurably superior to the old ones.

Even grave critics, intelligent enough to recognise the interest and beauty of harpsichord and clavichord music, are not above rhapsodizing about the "prophetic" genius of Bach, who wrote music which could only sound perfect upon the instruments of the following century. That was "music of the future" indeed! We read speculations about the delight of Bach if he could only have heard his clavichord music performed upon our gorgeous new pianos.

Surely this is nonsense, on the face of it, and everybody ought to see it, for even assuming the old instruments to be inferior to the new, which they are not, yet, it must be as wrong to play the music that was written for them upon modern instruments, as it would be to repaint the pictures of the fourteenth century under pretence that they are painted in tempera, whilst oil colour is preferable.

In music, as in any art, it is not the material employed that matters, for if the worker be an artist, he will produce a work of art with whatever material he can get, whilst if he be a bungler, no amount of fine material can help him.

These ideas, which have long been recognised in the other arts, seem little short of revolutionary in music, for the "arrangers" have the formidable support of authorities at their back. Did not Mozart reorchestrate Handel's "Messiah"? And did not some German, I forget whom, repaint—I beg your pardon—reorchestrate Mozart's "Don Giovanni?" Not a year ago the Philharmonic Society sanctioned a performance of Purcell's "Golden Sonata" by all the strings in the orchestra, accompanied by two grand pianofortes; and the authorities of the Royal College of Music had wind instruments parts added to "Dido and Eneas."

Should anybody dare to treat an old painting in that way, he would be promptly locked up.

I will now shortly describe the instruments we are going to use. I have brought two harpsichords; one made in London by Jacobus Kirckman in 1758, the other constructed by myself only a few months ago. The Kirckman is a beautiful instrument with two key boards, five stops, combination and swell pedals, capable of producing many varieties of tone and instantaneous changes of stops.

My new harpsichord possesses only two varieties of tone; but, by a contrivance of my invention, its tone can be increased or diminished at pleasure, not by putting stops on and off, but in the same quality of tone; just as the harp player can pluck his strings with more or less power. It possesses a greater volume of tone than the old harpsichord, which renders it fit to accompany the recitations of such works as Bach's "Passion," when performed in a large hall.

The tone of the harpsichord is produced not as in the pianoforte by the blow of a hammer, but by a plectrum of quill, or leather, which plucks or twangs the strings.

Some people admire the harpsichord the first time they hear it; others more or less object to its "tinkling," or the slight scratching of the quills. They only need more intimate acquaintance to properly appreciate it. The tone of all musical instruments is accompanied, more or less, by disagreeable noises. In the pianoforte the hammering is so powerful that it has not been possible yet to obtain a good record of its tone upon the phonograph. Yet, people come, by use, to disregard it almost entirely, and to hear only the music.

This clavichord is a new instrument of my own make. The action of the clavichord is quite different from either the harpsichord or pianoforte. It is very simple, yet difficult to explain clearly in a few words. At the end of the key is fixed a little piece of brass called the tangent, which, when the key is pressed down, comes to touch the string, "stopping" it at the required length to produce the note wanted, like the fingers of the left hand of a violinist, and at the same time causing it to sound. The player seems to feel the very strings of the instrument with the tips of his fingers. He can, by augmenting the pressure, produce a swell upon each note, or make it tremble like a voice under the influence of a deep emotion. These beautiful and valuable effects are not obtainable on the pianoforte. The clavichord is capable of intense expression: it all but speaks; but it has a drawback: its tone is very soft; it could not stand against the noise of conversation. Yet, in a moderate-sized room, when the audience keeps such a perfect silence as I hope you will keep when the time comes, even its softest *pianissimo* is distinctly audible, on account of the great purity and carrying power of its tone.

The viola da gamba is by Carlo Bergonzi, of Cremona, 1720. With its seven strings, its compass is larger than that of the violoncello, extending from the A below the bass stave to very high in the treble, with marvellous purity and flexibility of tone. On account of its tuning, by fourths and thirds, instead of the customary fifths, many double stops and chords can be played upon it which are not possible upon the violoncello.

Of the violins, I need say nothing except that they are both very fine instruments; the one a Maggini, the other a Guarnerius.

We will now proceed with our programme of music, but, I shall ask you to direct your attention on the special effects produced by the instruments, and to notice particularly how perfectly the tone of the harpsichord blends with the stringed instruments, whilst the pianoforte never can agree with anything else; its only resource in concerted music, being to overtop all the others.

PROGRAMME.

PART I.—HENRY PURCELL.

1. Sixth Suite for the Harpsichord.
   (i) *Prelude.* (ii) *Allemande.* (iii) *Courante.*

I am sure you will have noticed the varied effects of colour of which this instrument is capable, and you will easily understand that this music when played on the pianoforte would sound quite different, and would be in fact, very uninteresting. Of course, music written for the piano, like that of Brahms or Schumann, is made by great artists for a certain instrument, and is properly expressed by it, and that accords with what I said in the beginning; these men, being great artists, used the piano and produced works of art upon it; but music written for the harpsichord is not laid out for the piano, and when played on the piano the whole of the effect intended by the composer is spoiled.

You will next hear a beautiful sonata for the violin and harpsichord, the only one by Purcell. The harpsichord part has a figured bass, and there are many chromatic harmonies—what may be called quite advanced harmonies—to be found in it. Purcell was altogether a far more original man than Handel. Handel was very great in every way; he took all he found around him, and used all material to hand with great skill; but he did not invent. Purcell, on the other hand, was an original genius, who did not scruple to do any thing which had not been done before, and every one of his experiments proved successful.

I may tell you in connection with my new harpsichord, for it is especially intended for accompaniments and orchestral purposes, and as the pitch is now rather variable—a great many people using the French pitch, and many still using the English pitch, whilst I have a pitch of my own, a semitone below the French—I have made this instrument so that it can be transposed to anyone of those three pitches.

2. Sonata for the Violin, accompanied by the Harpsichord.
3. Sonata in F ("the Golden") for Two Violins, Viola da Gamba, and Harpsichord.

PART II.—GEORGE FREDERIC HANDEL.

4. "Suite Première" for the Harpsichord.
   (i) *Prelude.* (ii) *Allemande.* (iii) *Courante.* (iv) *Gigue.*
5. Sonata for the Viola da Gamba and Harpsichord.

PART III.—JOHANN SEBASTIAN BACH.

6. Fantasia Chromatica for the Clavichord.
7. Sonata No. 2, in A major, for the Harpsichord and Violin.
8. Toccata in G major for the Harpsichord.

To show the curious way in which music of this date is now treated, here is a copy of the sonata which we are next going to play, in a very well known edition, in which, although Bach has written a figured bass for three-fourths of the piece, the printers have simply given the bars in octaves, all the harmonies and chords indicated by the composer being completely disregarded. That is not the way we are going to play it.

9. Gigue from Sonata for Two Violins, Viola da Gamba, and Harpsichord.

Mrs. Elodie Dolmetsch performed on the Harpsichord and the Clavichord; Mr. Arnold Dolmetsch and Mr. H. M. Matheson on the Violins; and Miss Hélène Dolmetsch on the Viola da Gamba.

The CHAIRMAN said it was rather late to begin a discussion, but if anyone had any questions to ask he had no doubt Mr. Dolmetsch would be very pleased to answer them. If not, there only remained the pleasing duty of returning a very hearty vote of thanks to Mr. Dolmetsch and to Mr. Matheson and the ladies who had assisted in the illustrations, to the former for his very interesting paper, and to his coadjutators for the brilliant manner in which they had carried out his wishes.

The vote of thanks was carried unanimously, and the proceedings terminated.

THE SOCIETY OF ARTS AND THE 1862 EXHIBITION.

[In the *Journal* for November 6th, 1896, an account was given of the origin of the 1851 Exhibition. Another chapter of the Society's history, dealing with its connection with the 1862 Exhibition is now published.]

When the proposal for the 1851 Exhibition first took shape it was intended that it should be the first of a quinquennial series of such exhibitions. The importance, however, and the magnitude of the enterprise quite precluded any idea of repeating so great an undertaking every fifth year, but as the ten-year period from 1851 approached suggestions began to be made for holding a second exhibition. Sir Henry Cole tells us in his autobiography that he and Mr. Wentworth Dilke had discussed the matter in the early part of 1858, and in February of that year Mr. Dilke, who was then Chairman of the Council of the Society, submitted to the Council a memorandum from Mr. J. C. Deane proposing that there should be held in London in 1861 a Great International Exhibition of Arts. Mr. Deane had been associated with the Art Treasures Exhibition held at Manchester in 1857, and the memorandum was the outcome of a conversation which he and Mr. Dilke had had at Manchester. According to Mr. Deane's proposal, the exhibition was to consist of two divisions, Ancient Art and Modern Art. The matter was discussed at numerous meetings of the Council and various suggestions were made. Eventually it was determined, on the 28th March, 1858, that a series of decennial exhibitions was desirable, that an International Exhibition should be held in 1861, and that steps should be taken for the formation of a guarantee fund. The exhibition was to deal with Art and Industry (Fine Art had been excluded in 1851) and was to include music; it was to be mainly an exhibition of progress. As soon as the guarantee reached a certain sum, £100,000 or £150,000, an Executive Committee of three was to be nominated. Eventually in May a series of resolutions was finally agreed to which practically embodied these proposals.*

On the 5th May a committee was appointed to wait upon H.R.H. Prince Albert and to submit the scheme to him. This Committee consisted of Mr. Harry Chester, Mr. Henry Cole, Mr. Thomas Winkworth, Mr. J. Scott Russell, Sir T. Phillips, Mr. P. Graham, and the Chairman, Mr. Dilke. The Prince, however, was away and could not receive the deputation at the time, so beyond the publication of the resolutions of the Council no further step was taken at the time.

The announcement, however, of the Society's proposals naturally attracted public attention, and considerable discussion took place both inside and outside the Society as to the best site for the exhibition. The sites which found most public favour were Battersea-park and the estate at South Kensington which had been purchased by the 1851 Commissioners with the surplus of 1851. This estate at the time consisted of the block of ground now occupied by the Natural History Museum, the Imperial Institute, the Albert Hall, and other buildings, and the site proposed for the exhibition was the southern extremity of this plot, where the Natural History Museum now stands. Those who were moving in the business on behalf of the Society were strongly of opinion that the proper site was at South Kensington, and indeed it was a question whether it was not the duty of the 1851 Commissioners to take entire charge of the proposed exhibition.

It was early in December, 1858, that the Society brought the matter officially under the notice of the Commissioners, and asked them whether they were willing to undertake the management of the exhibition. They were the trustees of the surplus of the 1851 Exhibition, and in that surplus was included the amount of the subscriptions (£67,896) which had been originally given to start the exhibition. It was urged in many quarters that the funds thus provided should be available for exihibition purposes, and that if a second exhibition was wanted, the Commissioners of 1851 were the proper persons to carry it out. The Commissioners did not meet until the 19th February in the following year, when they replied asking for further information as to the prospects of the scheme, and the support it was likely to receive from manufacturers, and from the public. They stated that they had no funds to meet the expenses, but that if the report was favourable they were willing to consider how they could effectively help the undertaking. To this communication the Council replied on the 11th March, 1859, promising that they would endeavour to collect information, and would try to obtain subscriptions to a guarantee fund of £250,000 on the understanding that the Commissioners would initiate it by a contribution of £50,000. It does not appear that any definite steps were taken to form such a fund, but informal promises were received from a number of the Members of the Council and their friends of sums amounting in the aggregate to over £70,000.

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* The resolutions agreed to were published in the *Journal* of the 16th April, 1858; vol. vi., p. 333.

In the midst of the negotiations the Franco-Austrian war broke out (on the 26th April, 1859), and after very considerable consideration it was determined by the Council that it would be wiser to postpone the holding of an exhibition. This conclusion was not arrived at without careful consideration, for the opinion was warmly urged that a state of war on the Continent ought not to be allowed to interfere with so industrial and peaceful an enterprise as an exhibition, and it was further argued that even if no foreign nations co-operated, a sufficient exhibition could be formed of British productions alone. However, the more cautious counsels prevailed, so a formal resolution of postponement was adopted, and was publicly notified at the annual general meeting of the Society, held on the 29th June, 1859.*

The war, however, was brought to a conclusion much more rapidly than had been expected, and peace was concluded in July. On the 2nd November, 1859, the Council passed a resolution to resume proceedings, postponing, however, the date of the Exhibition till 1862, and to take steps in order to obtain a guarantee fund of £250,000. They also appointed a committee to prepare a form of guarantee and to deal with exhibition matters generally. This committee consisted of Mr. Cole, Mr. Uzielli, and the Chairman of the Council, Sir Thomas Phillips. The committee reported on the 22nd February, 1860, and in pursuance of their report, a form of guarantee was adopted and five trustees were nominated—Earl Granville, the Marquis of Chandos (afterwards Duke of Buckingham), Mr. Thomas Baring, M.P., Mr. C. Wentworth Dilke, and Mr. Thomas Fairbairn, who had been chairman of the Art Treasures Exhibition at Manchester in 1857. These proceedings were reported to Prince Albert by a deputation from the Council on the 28th February.

The guarantee form adopted took the shape of "an agreement for holding an international exhibition in 1862." This was signed by the intending guarantors, and afterwards, when it became necessary to raise money for the purpose of the exhibition, a formal deed was executed, and it was signed by the guarantors. Under the provisions of this agreement, it was resolved that no subscriber should be liable until £250,000 at least was guaranteed; that the undertaking was to be under the management of the five trustees above named, who were to have full control of the exhibition; that the trustees should apply to the Commissioners for the 1851 Exhibition for the grant of a portion of their estate at South Kensington as a site for the intended exhibition, but that they should have power, if they could not obtain such site on favourable terms, to obtain any other suitable site; that one-third at least of the sum expended on buildings should be employed on erections of a permanent character, to be used by the Society for holding decennial or other periodical exhibitions, and for other purposes tending to the encouragement of arts, manufactures, and commerce; that at the close of the exhibition the temporary buildings should be sold. If there should be a deficit, which the Society of Arts declined to liquidate, that the permanent buildings should be sold, and that after such sale, if there was still a deficit, the ultimate loss was to be paid by the subscribers *pro rata*. If there was a surplus it was to be applied in a manner to be determined by the guarantors themselves to the encouragement of arts, manufactures, and commerce.

In deciding on the terms of this agreement, the Council were evidently inspired by two ideas, first, to secure for the Society some tangible results from the success of the project, if success there was; and secondly, to make provision for the regular holding of exhibitions at stated intervals.

It is noticeable that a financial success was looked upon as assured. The large profits from the first exhibition made it but reasonable to expect that a second, managed with all the benefit of the former experience, would produce even larger gains, and doubtless it seemed but prudent to avoid the discussions and controversies which had arisen about the disposal of the first surplus.

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* The report of the Council, presented at this meeting, gives a full account of the correspondence between the Council and the Commissions, and of the proceedings previous to the decision of postponement. See *Journal*, vol. vii., p. 557, July 1, 1859.

With management as skilful as that of 1851, it seems probable that 1862 might have been made a source of profit, as an exhibition on a similar scale might be at any time, but this is only a speculation, and experience has long since taught the lesson that international exhibitions on the scale on which they are now held, cannot possibly prove remunerative, but must always involve a heavy expenditure.

On the 8th March, 1860, a copy of the guarantee agreement was sent to the Commissioners of 1851, and an application was made on behalf of the Society for the grant of a suitable site. The Commission being in doubt as to the means at the disposal of the Society for carrying out their proposal delayed response; but on a further letter being addressed to them in June, 1860, containing the information that the guarantee fund had been subscribed to the amount of £308,350, the Commissioners expressed their readiness to appropriate a portion of their estate, rent free, for the exhibition; and to vest in the Society of Arts, at a moderate rent, the site of the permanent buildings proposed to be erected, provided that the sum of £50,000 was expended on their erection. They, moreover, undertook to reserve the remainder of the ground for an International Exhibition, to be held in 1872, provided £10,000 were paid to them out of the proceeds of the 1862 Exhibition.

There was a good deal of further correspondence between the Society of Arts, the Trustees, and the Commissioners*, and amongst other suggestions it was proposed, at the instance of Lord Granville, and with the concurrence of the other trustees, that the management of the exhibition should be handed over to the 1851 Commission. This proposal, however, was not accepted by the Commission for various reasons, one of them being that as the guarantee agreement entrusted the control of the exhibition to a body of trustees specifically named, the agreement would fall to the ground if the management was transferred from the trustees to the Commission. The Commission, however, undertook to assist the trustees, and on that understanding the trustees agreed, in November, 1860, to accept the trust on the condition that a charter of incorporation was obtained for them by the Society of Arts.

A charter accordingly was applied for by the Council of the Society on behalf of the trustees, and was granted under date of the 14th February, 1861.* This charter incorporated the trustees under the name of the "Commissioners for the Exhibition of 1862," and gave them full power to take all necessary steps for the management of the exhibition, including the power of borrowing money for the purpose. It stipulated that a sum not exceeding £50,000 was to be expended on buildings of a permanent character adapted for the purposes to which the Society of Arts might put them, as previously agreed, the conditions for the ultimate disposal of these buildings being the same as those set forth in the guarantee agreement. If there was a loss, the Society of Arts was to have the option of making it good, and taking over the permanent buildings. If there was a surplus, £10,000 was to be paid to the 1851 Commissioners for the use of a site of sixteen acres for an exhibition in 1872; the balance, as above stated, to be employed as the guarantors might decide.

The trustees did not wait for the formal issue of the charter, but took some provisional action before they commenced their labours, and they soon came to the conclusion that it would be impossible for them to carry out the condition of spending not less than £50,000 on permanent buildings. They therefore proposed that the sum to be spent on permanent buildings should be reduced from £50,000 to £20,000, with the understanding that if at the close of the exhibition the necessary funds were available, the difference should be made up. This was agreed to by the Society of Arts and by the 1851 Commission, and these conditions were substituted for the conditions described as having been stated in the charter.

The full control of the exhibition was now vested in the Commissioners appointed for the purpose, and passed out of the hands of the Society of Arts, which however was still occupied with its duty of increasing the guarantee fund, which was eventually raised to £451,070, contributed by 1,157 subscribers.

It will therefore be seen that the Society had a more intimate connection with the management of the 1862 Exhibition than with that of 1851. In both cases the preliminary organisation was due to the Society, and in both cases the early preparations was made by, and at the risk of the Society, but the exhibition of 1862 was managed by a Commission appointed by the Society, whereas the Commission of 1851 was an entirely independent body, the Society having had no voice in the selection of its members.*

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* The whole of the correspondence is printed in the Fourth Report of the 1851 Commissioners.

* See *Journal*, vol. ix., p. 205; 22 Feb. 1861.

At the conclusion of the exhibition it was found, as is well known, that the receipts had been insufficient to defray the expenses. Eventually it was agreed that the contractors —Messrs. Lucas and Kelk—should agree to take over the whole of the buildings, alike the temporary erections and those which had been intended to be permanent, in discharge of their claims against the Commissioners of 1862; and in addition to this, one of the members of the firm—Sir John Kelk—personally gave the sum of £11,000 to the Commissioners to enable them to balance their accounts without making any call upon the guarantors. The anticipation of the Society, therefore, that it would enter into possession of buildings at South Kensington suitable for the holding of exhibitions, and for other purposes, was not realised, and, as in 1851, it derived no profits from the undertaking.

An important service was rendered to the exhibition by the Society of Arts by the publication of the jury reports. As no provision was made for the publication of the reports, and as it did not seem probable that any funds would be available, a suggestion was made to the Society that they should undertake the duty. They accordingly made an offer to the 1862 Commissioners to provide for the publication of the reports of the jurors, provided the reports were supplied for the purpose. It was intended that the volume should appear immediately at the close of the exhibition; but, as is frequently the case in work of this sort, unavoidable delays prevented this intention from being carried out, and the book did not appear until the close of 1863. As a financial speculation the work was not a success. The cost of publication was £2,340, of which the Society received back £1,548 from sales of the book, thus making a loss of £792.

The want of financial success attending the 1862 Exhibition prevented any attempts being made to repeat the experiment of a great international exhibition at the end of the next period of ten years; but in 1868 Sir Henry Cole induced the Provisional Committee of the Albert Hall to recommend to the 1851 Commissioners proposals for a series of annual international exhibitions to be confined to specific subjects, and to be extended over a period of ten years. The Commissioners, after some hesitation, accepted the proposal, and devoted some of their funds to the construction of buildings surrounding their estate at South Kensington, the centre part of which had then been leased to the Horticultural Society. The galleries then erected, after serving their intended purpose from 1871 to 1874, were some of them at a later date utilised for the Fisheries and succeeding exhibitions. Others were devoted to the science collections of the South Kensington Museum, the India Museum, &c. The first of these exhibitions was held in 1871, and they were continued for three years more. Though the first brought in a profit, and attracted a large number of visitors, they grew less and less popular; the series, as a whole, was not pecuniarily successful, and after 1874 it was dropped.*

The Society of Arts was associated, but not very intimately, with the scheme. The *Journal* was made the official organ of the exhibitions, and several of the sectional committees were organised by the Society. In 1872 a member† of the Society of Arts offered anonymously a sum of £500 to encourage the development of improved means for the economical consumption of coal in private dwellings. Prizes were accordingly offered for improved stoves for domestic purposes, with the intention that the competing articles should be tested, and shown in the 1874 Exhibition. An elaborate series of experiments for testing these stoves was carried out in buildings specially constructed for the purpose, on ground adjoining the exhibition buildings; but no very satisfactory results were attained, and no prizes were awarded, the cost of the experiments having exceeded the amount of £500 offered.‡

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* For detailed information as to the management of the exhibition, construction of buildings, financial results, &c., reference may be made to the report of the 1862 Commission published in 1863; to the fourth and fifth reports of the 1851 Commission, and to the introduction to the Official Illustrated Catalogue, 1862.

* A brief account of these exhibitions will be found in the sixth report of the 1851 Commissioners, and a full account in a special report made to the Commissioners by Sir Henry Cole. Reports on the three last exhibitions were published by the Society in the *Journal*, and those for 1872 and 1873 were reprinted separately.

† Mr. John Noble, who died in 1890.

‡ See *Journal*, vol. xxiii. 1874, p. 83.

That the scheme for special exhibitions was in itself a good one is shown by the success ten years later of exhibitions of a similar character, and in the same situation. But the manner in which it was carried out was not entirely satisfactory, and with the experience that has since been gained, it is not difficult to assign the reasons for non-success. The long galleries surrounding the gardens on all four sides were not very well suited for the purposes of an exhibition, but this could, and probably would, have been remedied, had there been a demand for more and better accommodation. From the outset the lighter side, the amusement side of the exhibition, was neglected, and when disputes arose between the Commissioners and the Horticultural Society, ending in the closing of the gardens to exhibition visitors, the principal attraction was cut off, and the public ceased to support the enterprise. The experiment, however, did not involve a very serious strain on the Commissioners' resources. The total deficit for the four years was under £14,000, less than the interest on the capital sum devoted by the Commissioners temporarily to the purpose.

BRITISH MINES AND QUARRIES.

The second annual report upon the mineral industry of the United Kingdom of Great Britain and Ireland for the year 1895 by Dr. C. Le Neve Foster, F.R.S., has lately been published. It contains a large amount of information respecting the mines of the United Kingdom, arranged under the several headings:—(1) Persons employed; (2) minerals raised; (3) accidents; (4) prosecutions; (5) general remarks; and these divisions are followed by a comparison with foreign countries. Several appendixes are added to the report, and also illustrated maps and diagrams.

Dr. Foster points out that in this year's report he for the first time gives information about quarries, which are now regulated by the Quarries Act of 1894. He therefore classifies the workings for minerals as follows:—1. Mines (*a*) under the Coal Mines Regulations Act; (*b*) under the Metalliferous Mines Regulation Act. 2. Quarries (*a*) more than 20 feet deep, which are now under the Quarries Act; (*b*) 20 feet deep and less, which are not under the Quarries Act. 3. Brineworks. The last class, and the quarries less than 20 feet deep, are under the Inspectors of Factories.

It appears that "of the 733,657 persons employed at mines, 584,298 worked below ground, and 149,359 above ground, of whom 5,636 were females. Compared with the previous year, there is a decrease of 5,391 males working below ground and a decrease of 10 males and 39 females working above ground, making a total decrease of 5,440 persons."

The total number of persons employed inside and outside the quarries in 1895 were 104,625 (or 53,915 inside and 50,710 outside). The number of quarries under the Quarries Act amounts to more than 8,000.

The total value of the metals extracted in 1895 was £11,472,225 (of which sum that of iron alone came to £10,534,325). The total production of coal in England in 1895 was 133,760,636 tons (or 5,566,778 tons less than in 1894), and the value of the mines £38,488,435; production of Wales 27,973,647 tons, and value £10,014,203; production of Scotland 28,792,693 tons, and value £7,672,747; production of Ireland 125,586 tons, and value £52,978; making a total production in the United Kingdom of 189,652,562 tons at an approximate price per ton at the mines of 6s. per ton, and a total value of £57,228,363.

Dr. Foster has investigated the question raised by the late Professor Stanley Jevons in his work on "The Coal Question" (1866), as to the probable exhaustion of our coal mines within a calculable period, and has placed the figures representing the amount of coal actually raised during the last thirty-five years by the side of those of the imaginary output. He finds that the actual figures fall very short of those Professor Jevons arrived at. Comparing the years 1864 and 1854 Jevons found that the average rate of increase in the output of coal was 3·7 per cent., and for the purpose of his calculations he assumes "that the average annual growth of our coal consumption is 3½ per cent., or the ratio of growth is that of 103·5 to 100." On this assumption Jevons calculated that in 110 years the amount of coal consumed would be one hundred thousand millions of tons. Dr. Foster gives a table of the quantity of coal raised in the United Kingdom from 1861 to 1895, and remarks that it is interesting to note how closely the calculated amount agree with the actual figures for the first 15 years. After 1875, however, the real figure invariably falls short of the calculated figure, and in 1895 the difference is nearly 80 million tons. The average annual rate of increase in the actual output of coal has fallen from 3·3 per cent., which was put after Jevons wrote, to 2·8 per cent., which is the average of the whole 35 years, 1861-95. Dr. Foster concludes that "the difficult problem of determining the duration of our coal supply evidently requires further consideration." The third part of the report is devoted to the consideration of accidents, and it appears that there were 1,016 fatal accidents which caused the loss of 1,198 lives. Of these accidents 914 causing the loss of 1,096 lives happened at mines, and 102 causing the same number of deaths happened at quarries. From a table of fatal accidents classified according to the mineral worked, it appears that in coal mines the number of accidents was 864 and the number of deaths 1,020; in iron mines the number of accidents 21 and the number of deaths 21; and in other mines 47 accidents and 55 deaths.

In conclusion Dr. Foster refers to the result of Dr. Haldane's investigations in the causes of deaths in colliery explosions, which is that most of the deaths in a great colliery explosion are due to poisoning by carbon monoxide and not to violence. Dr. Haldane therefore suggests precautionary measures which may be taken by persons who have escaped the first effects of the explosion and by those engaged in the perilous task of trying to rescue them.

GREAT TERRESTRIAL GLOBE.

Mr. T. Ruddiman Johnston proposes to construct for exhibition in London, a great terrestrial globe, on the scale of $\frac{1}{500000}$ of nature, or a globe having a diameter of 84 feet, and showing the earth's surface on a scale of about eight miles to the inch. In order to show the effect of the globe, Mr. Johnston has prepared the following sections to give an idea of the appearance of the surface of the globe:—England and France, from Middlesbrough on the north, and Preston on the west, to Paris on the south and east; the North-Western Frontier of India; Egypt; Gibraltar, &c.; Turkey, &c; Uganda, &c. The globe will be seen from a spiral gallery running round and round it, to the upper end of which the spectator will be taken by an elevator, and as the globe is slowly revolved every portion of its surface will come in view.

Mr. Johnston thus describes his plan more fully:—On the proposed globe every geographical feature of importance will be shown and named, as will also be every city or town having 5,000 inhabitants, and a large section of others with a smaller population. The scale of the globe will not only permit of this being done, but, besides showing towns, according to population, in seven sizes of lettering, it will allow the larger cities to be drawn to scale, which will give a living interest to the globe. London, for instance, will on it cover a space rather larger than that of a penny. Cities with a population of over 100,000 will have their names very boldly lettered, so that anyone examining the globe can, by selecting a city known to him, quickly find the smaller places with which he may not be so well acquainted.

As all colours and of all strengths can be employed, great clearness can be obtained by showing rivers and lakes in blue, mountains in their natural colour, plains in green, deserts in yellow, roads in grey, and railways in red; and the names of these can each also have a distinctive colour. The colours again used on the physical features will be kept cold at the poles, and gradually warmer as the tropics are approached.

On the oceans there is ample room to show currents, prevailing winds, temperatures, salinity of the sea, the depth and nature of ocean beds, pressure of the atmosphere and variation of the compass; but on the land, though the geographical distribution of plants and animals and even other matter may be indicated, it should not be lost sight of that the globe is not intended to supersede atlases and reference books, but to encourage their use, and that the general public will visit it more to see where they and others are, or to ascertain quickly from it some desired general information, than for scientific research.

Mr. Johnston has also projected a great hollow terrestrial globe which would be viewed from a platform within the globe, as was the case with Wyld's globe, erected in Leicester-square in 1851. A hollow globe could be produced more cheaply than the other, and as the space used for the spectators on the outside would be dispensed with it could be planned on a larger scale.

THE BEET SUGAR INDUSTRY IN FRANCE.

A large acreage of beets is sown annually, and this is not surprising, seeing that even in unfavourable seasons the crop pays the farmer better than wheat or any other agricultural product. In 1894 more than 1,7000,000 acres of land was planted in beets, giving a total production of 18,400,000 tons of the root, or an average of nearly 11 tons per acre, with about seventeen shillings per ton for forage and the manufacture of beet sugar. From 50 to 60 per cent. of the beet raised in France is manufactured into sugar, the yield being from 7 to 9 per cent. of the gross weight of the root. The United States Consul at Havre says that there has been less activity in beet sugar during the years 1894–95 and 1895-96 than for several preceding years, owing to the bounty paid by Germany on sugar exported from that country. Considerable quantities of the strong, low grades are purchased for the United Kingdom, but the better qualities are kept for the home refineries, which are for the most part situated at or near Paris, and in the north of France. The fine white crystallised sugars are principally taken by England, Morocco, the Argentine Republic, Algeria, and Turkey. The consumption of French sugar in foreign countries might keep better pace with the production if it were not for the bounty system adopted by other European countries, notably Germany. There is absolutely no waste of the beet product. Every part of the vegetable is utilised and rendered valuable in one way or another, whether it be used for sugar or for forage, or the two combined. The pulp of the root, after the juice has been expressed for sugar, is eagerly devoured by cattle, and is found to be exceedingly nourishing. Not only the roots but the leaves and stalks are utilised as food for cattle, and it has been found that especially when fresh, they not only increase the animals' fat but also largely increase the secretion of milk in the cow. The dry leaves and stalks, when mixed with straw, afford excellent and wholesome food during the winter for cattle and sheep. Altogether, the beetroot, or the residue after the juice has been expressed, supplies with the leaves and stalks, nourishment for cattle and sheep more abundant, perhaps, than any other forage that could have been cultivated on the land. It is, moreover, stated that a large profit is derived from selling the leaves to tobacco manufacturers, who prepare and mix them with the tobacco which is made into cigars and cigarettes, in fact it has been asserted that certain beet growers realise enough from leaves sold for tobacco to pay all the expenses of cultivating the crop. The beet at present is commanding attention in France as applicable to another purpose than that for which it has hitherto been principally used. The French Minister of Commerce is taking the initiative in a very interesting matter which may eventually prove to be of considerable benefit to French agriculture. He has conferred with several scientific men for the purpose of organising a competition, on which the sum of £4,000 will be expended with the view of ascertaining whether alcohol extracted from potatoes and beetroots cannot be effectively utilised for lighting purposes. It is argued that this would be a valuable industry, the more so, as the supply of petroleum in America appears to be on the decrease. A great deal depends in beet culture upon the position of the ground. A soil too damp is not suitable for the sugar beet, because in this case the root gains in quantity, but loses in quality; a soil moderately humid and exposed to the mid-day sun is preferred. It is necessary, above all, to avoid land which is shaded by trees, and over which the air cannot circulate freely. The land is manured from six to twelve months preceding the planting of the beet. The cultivation of the field is made in three ways: (1) by sowing the seed; (2) by planting the capsules which contain the seed; and (3) by plants raised in the hothouse. The seed of the beet being enclosed in a capsule of three, four, and five divisions, it is difficult to open the capsule without damaging the seed, it is therefore considered best to plant the capsule itself. When seed is used, the beds are prepared and the seed planted in the middle of April, or not later than the end of that month. They are sown in properly arranged furrows and covered with a harrow, or with the hand, to the depth of half an inch or an inch. Five pounds of seed are required for one acre of ground. When the weather is warm and favourable, the ground sufficiently wet, and the seed good and fresh, they will sprout in about eight days, otherwise they may not germinate for fifteen or twenty days. The increase of the beet is very rapid after the first working. The crop is gathered towards the end of September, for at this time the beet has generally acquired its full growth. A dry time is most favourable for gathering the crop, and care should be taken not to expose the beet to too much dampness, which causes fermentation and the destruction more or less of the sugar principle. The manufacture of the beet into sugar usually begins in the month of October, though it may be deferred for several months if the beet is kept in a dry, warm place, where there will be no danger of frost. The work of extracting sugar from the beet requires several distinct processes which may be named in the following order:—(1) Cleaning the roots; (2) trituration or cutting into small bits; (3) pressure or diffusion; and (4) evaporation. It is unnecessary to note the various methods of washing the beet. This is effected by hand or machinery as may seem best to thoroughly cleanse the roots of all dirt and grit. Where the old method of extracting the juice is used, the root is first finely triturated and then subjected to pressure. Under the new method, the sugar is extracted, and by the process known as "diffusion," which is based on the physical phenomena of endosmose and exosmose. The roots, previously cut into small bits, are immersed in water, and the interchange between the water and the sweet juice of the beet begins at once through the intermediary porous partition represented by the cells of the beet substance which separates the water from the juice contained in the cells. The method has a great advantage over that of pressure, which detaches part of the fibrous texture of the beet and renders the juice more or less impure. Moreover, the pulp from diffusion contains more organic matter than that obtained from pressure, and is much more valuable as food for cattle on account of its greater nutritive properties. The diffusion process has now been applied to the extraction of sugar from the sugar cane, and a French company has during the last decade established several plants of the kind in Spain, which are said to work with great success, the cane used being imported from Cuba.

THE WOODS OF PARAGUAY.

Of the next importance to the yerba industry in Paraguay, is its timber. Immense forests of various classes of woods are to be met with in all parts of the country, whether it be inland or on the shores of the two greater rivers, the Alto Parana and Paraguay. These woods are chiefly exported in the shape of square logs and are transported considerable distances, often as much as forty or fifty miles from the interior to the railway, or sent down the river in rafts or large barges. They are now finding ready markets in Rosario, Buenos Ayres, Montevideo, and Europe, more especially in Germany, Belgium, and France. They may be divided into two classes, viz., hard woods (*madera de ley*) which do not float, and soft woods. The United States Consul at Asuncion says that the hard woods are chiefly used by the railways for sleepers, bridge work and general railway construction; the lighter woods, with the exception of cedar and petereby negro, are sawn up into planks chiefly in Asuncion, and in South America to a great extent, take the place of pine, which wood, being imported from Europe and North America, is expensive. It is said that the hard woods of Paraguay will compare favourably with any wood in the world in durability and strength. It is well known that some of these after being under ground or in water from fifty to seventy years, or even longer, are found to be perfectly sound, with only a slight superficial corrosion, and for this reason there are now large orders from Buenos Ayres and Montevideo for wood of this class for piles which can be supplied at a less cost than pitch or creosoted pine. There are other hard woods close grained and yet elastic, which compare favourably with the English oak and the American hickory which resist the wood borers and are uninflammable. As regards the soft woods the chief export is cedar. Paraguayan cedar is far superior, and commands a higher price than the cedar found in the northern parts of the Argentine Republic. It is richer in colour and more durable than its larger growing brothers to be found in Tucuman and in the Argentine and Brazilian Missiones. For durability and for retaining its scent, the *cedro* is thought to be superior to any other cedar hitherto used in the manufacture of cigar boxes and receptacles for the preservation of apparel from the depredations of insects. The best cedar hitherto exported to Europe has come from Cuba, but the supply from there is now practically exhausted, and the revolution has put an entire stop to its exportation for the present. Among the various palms which are to be found in great quantities in the Paraguayan Chaco are the red and black palms. These are extremely hard, and will often turn the edge of the best axe. The black palm makes a magnificent veneer, taking a beautiful polish, and when in water or underground it is practically everlasting. Large quantities of a small brush-like tree called *espanillo*, and another called *algaroba* are cut into posts and sent to Buenos Ayres for fencing, and although they are sometimes not more than two or three inches in diameter, they will last underground forty or fifty years. The principal woods and their various uses are the following:—*Curupay*, a hard, red, heavy wood of great strength, lasting for many years underground, or in water. It is chiefly of this wood that piles for docks and bridges are made and a large demand exists for it for sleepers. The bark is used for tanning. *Curupay-ria*, a species of curupay of greater weight-bearing power, but inclined to crack when exposed to the sun. *Tinibo*, a light wood, not unlike cedar in grain, and as it often grows to an immense size, it is much used for canoes and troughs for water and treacle. *Tatané*, a handsome, yellow, hard wood. It makes an excellent veneer, is very durable underground, and resists insects and fire. Consul Thomé says it would be difficult to overestimate this wood. It is much sought after by shipbuilders for shoulders, and stem and stern posts. *Guayabi*, very flexible and elastic, greatly used for bullock yokes and axe handles. *Petereby blanco*, a light wood, and *Petereby negro*, one of the best woods in the country. The latter is much used for masts on account of its great length. Its value is difficult to overestimate. It takes a fine polish, is handsome for furniture, and is of great durability. It is highly scented, and extremely light. *Palo santo*, only found in the Paraguayan Chaco; much used for its chemical properties, and for fancy work in lathe turning. *Quebracho negro*—the king of hard woods. The significance of the name is axe breaker. There is no wood known to surpass it for durability and longevity either in earth or water. It is sent to Europe for tanning purposes. *Quebracho blanco* has almost the same properties as the other, but is of no use in tanning. A tonic is made from the bark, said to be beneficial in pulmonary diseases. *Lapacho*—immense quantities of this are shipped to Buenos Ayres for railway and shipbuilding purposes. It is a greenish yellow wood, which does not readily crack and is of immense strength. *Inviraro* (bitter).—One of the best woods in the country, close grained, not unlike oak in appearance. It has this great advantage, it does not crack and is invariably sound in its heart. This wood is used by the natives for the hubs or boxes of wheels and fellies, and these native-made wheels are as a rule made without iron tyres, proving the extreme hardness and durability of the wood, for the roads in Paraguay are of the roughest description. *Incienso.*—The sap of this is the incense of commerce, and of late there has been a demand for the wood for parquet flooring, on account of its scent, durability, and hardness. *Palo blanco* is one of the commonest and tallest trees in Paraguay. It is practically everlasting when not exposed to wind and weather. It has this great advantage, dry rot and borers never touch it.

BANANA CULTIVATION IN MADEIRA.

Two varieties of banana are generally grown in Madeira, viz., the dwarf banana and the silver banana. The dwarf banana, the *banana aña*, or Chinese banana, the botanical classification of which is *Musa Cavendishii*, of the order of *Scitamineæ*. Consul Crawford, of Funchal, says that this is the banana most preferred for the export trade, the fruit being much larger and the bunches much heavier than the silver variety of the fruit. The silver is much the more delicate in flavour, and only about one-half the size of the dwarf variety, but it is seldom exported, as the total quantity grown in the island is scarcely sufficient to supply the home consumption, but Consul Crawford says that in all probability if this variety of fruit were better known it would be in greater demand, and, although smaller in size, it has a much better appearance, being of a beautiful bright golden-yellow colour without any of the dark brown spots or patches which usually disfigure the dwarf banana when ripe, whilst, as regards the flavour, it is so much more delicate that those who have once eaten the silver banana seldom use the dwarf or ordinary variety, except for cooking purposes. The dwarf banana forms by far the largest proportion of the total quantity of fruit that is exported from Madeira. The greater part of the bananas are grown on the south side of the island in plantations varying from a few plants to many thousands; they thrive best on fresh land sheltered from heavy gales of wind, which are liable to uproot the plants and to damage the bunches of fruit. Artificial manure has been used with great success in their cultivation, but large quantities of offal from the slaughter-houses and the fish markets are also freely used, and this treatment is found to be most beneficial in increasing the weight of the bunches, and also of the individual size of the fruit. The season for bananas virtually lasts the whole year round, the largest export taking place during the winter months when fresh fruit is scarce in England, but the fruit is at its greatest perfection from July to December, being much more abundant, the bunches larger, and the fruit better flavoured. The banana is one of the very best fruits grown in Madeira for exportation, as the bunches can be cut whilst the fruit is green and firm, it sustains comparatively little damage in transit, and the fruit ripens by degrees according to the temperature in which it is kept. The usual method of packing is in large rough wooden crates, holding a dozen or more bunches, between each of which straw is placed to keep them firm and to prevent them rubbing one against another; another method of packing is in baskets made of a coarse native broom, one bunch only being placed in each basket, straw or bracken eaves being likewise placed round them to ensure their safety in transit.

MINERALS IN SERVIA.

According to the *Revue d'Orient*, Servia is rich in mineral products. Gold is found in a pure state in the bed of some rivers, such as Tzernarcka, Pek, Timok, Rasina, and Poustarék streams in the neighbourhood of Pirot. All the mineral districts of Servia contain silver in a greater or less proportion, in lead, arsenic, manganese, zinc, and copper. Quicksilver is found chiefly in quartz and serpentine, the chief vein being near the village of Ripany. There is a little copper almost everywhere, but chiefly near Pojarévatz and Valievo. The antimony is good, and is found in the provinces of Belgrade and Valiévo. Zinc exists in all the mineral districts most frequently mixed with sulphur. Nickel is also found, but in small quantities, mixed with quicksilver. Chrome has been discovered in serpentine, and the Government works a mine of iron chrome near Valiévo, of which great things are predicted. Coal is met with in nearly all tertiary formations of the kingdom, and all the Servian coalfields have by no means been yet explored; there are very few parts where researches have not brought new beds to light. Hitherto, the best coal has been found at Verkachanka, between the Pek and the Timok. This is coal of excellent quality, in seams 4 to 16 metres thick. The mine is connected with the Danube by a railway.

Correspondence.

MINING AT GREAT DEPTHS.

Mr. John Hays Hammond (The Consolidated Gold Fields of South Africa, Limited, 8, Old Jewry, E.C.) writes: — On page 68 of the *Journal of the Society of Arts*, I am quoted as stating "that the extra cost of deep level mining to 5,000 feet, should not exceed 5s. per ton." This statement was probably taken from an article written by me for the "Gold Mines of the Rand," by Messrs. Hatch and Chalmers. The 5s. per ton was, however, a typographical error. I should place the extra cost referred to under present conditions of mining at considerably under 1s. per ton. This refers to mining at depths of 5,000 feet vertically.

General Notes.

Institution of Civil Engineers.—At the meeting on Tuesday, December 22nd., at 8 p.m., Mr. E. C. Shankland will read a paper on "Steel Skeleton Construction in Chicago."

The Timber Trade of British Columbia.—The centre of the timber trade of British Columbia is Vancouver. Long before Vancouver was a city and the terminus of the Canadian railway, in the beginning of the sixties, there were two large saw mills there. The German Consul in Vancouver in a recent report states that Vancouver now possesses twelve. Although the innumerable forests of British Columbia are rich in conifers of various kinds, there are only three the timber of which is exported, the Douglas pine, the giant cedar, and the spruce fir. The first of these is the main object of export; it is shipped to all parts of the world, and forms a serious rival to Norwegian timber. The Douglas pine is chiefly used for masts, on account of its combining with great strength the requisite height and elasticity; it is also used for bridge building and railway carriage making. In the form of masts it attains a height of 120 feet, with a diameter of 28 inches. Cedar is mainly used for the manufacture of doors and windows; Japan imports it largely for the production of lead pencils. The wood of the spruce fir gives excellent timber for chests, and is largely shipped to Australia for that purpose. Of the total area of British Columbia, 75 per cent, is forest land

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 6 and 13, 1897, by CLINTON T. DENT, F.R.C.S., Past President of the Alpine Club, on "The Growth and Demolition of Mountains." The lectures will be fully illustrated with lantern slides and experiments. After a brief sketch of the growth of mountains, the following points will be discussed in the course:—The agencies which contribute to the demolition; wearing and weathering of rock; protective and destructive influence of glaciers; avalanches—the Altels avalanche in 1895—mountain falls—bursting of glacial lakes.

The lectures will commence at seven o'clock. Special tickets are required for these lectures, which can be obtained on application to the Secretary. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult. The cards are now in course of issue, and it is desirable that members requiring them should apply at once.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

THE USE OF GAS FOR DOMESTIC LIGHTING.

By Professor Vivian B. Lewes,
Chief Gas Examiner to the Corporation of the City of London, &c.

Lecture I.—Delivered November 23, 1896.

The use of coal gas for domestic illumination is so important a factor in most of our households that it might be expected that a fairly general knowledge would exist as to the principles upon which efficient illumination depends, and yet there are few subjects upon which cruder and more erroneous ideas are to be found not only amongst the general public but even amongst many who are supposed to have made a special study of the questions involved.

When about the middle of this century the Legislature began to attempt to safeguard the consumers, it was done by prescribing a certain standard of illuminating value to the gas, this being determined by the photometric methods then in vogue. This value was called the illuminating power of the gas, and up to a few years ago was looked upon by most people as expressing the amount of illumination to be obtained in practice from the gas, and the illuminating power as obtained by photometricians from various burners as representing the illumination to be obtained under ordinary circumstances from those burners.

Both of those assumptions are incorrect, and have given rise to a chaotic bemuddlement in the theory and practice of illumination.

During the past five years it has been gradually realised by many that illuminating power and illuminating effect mean two totally different things, and this apparent anomaly depends upon several distinct factors. In the first place, illuminating power or illuminating value is merely a technical method of expressing the ratio of light emitted by the combustion of a certain sample of gas as compared with the light of the standard candle, and has but little to do with the effect produced when the gas is consumed under conditions differing from those under which it was tested.

The fact that this has not been universally recognised has arisen from the duty of the gas engineer ending with the distribution of his gas, whilst the methods of burning it have been entirely left to the gas fitter or the consumer, the result being that whilst the engineer has looked upon the fulfilment of his statutory obligations as being the final object to be aimed at, the consumer, with the vaguest notions as to what the technical statement as to illuminating power means, has assumed that it represented the illuminating effect to be obtained from the gas.

Indeed, where the consumer has taken the trouble to find out what is meant by the statement that he is supplied with a 16-candle power gas, he learns that it means that when the gas is burnt at the rate of five cubic feet an hour in the London argand it emits a light equal to sixteen sperm candles, each consuming the sperm at the rate of 120 grains per hour. He assumes, therefore, that by burning his gas at the rate of five cubic feet an hour in a London argand, he gets the same illuminating effect in his room as if he had utilised the sixteen sperm candles.

Observation, however, would soon convince him that this is not by any means the case, and that if he distributes his sixteen sperm candles judiciously in his room, the illuminating effect produced is far superior to the London argand emitting the same amount of light from a gas bracket in the centre of the room, and this simple instance strikes the key note of the difference which exists between illuminating power and illuminating effect.

In the one case you have sixteen centres of light, each illuminating a certain portion of the room, and none of them sufficiently intense to form a contrast with the others ; whilst with the argand emitting its 16 candles of light from one small cylinder of flame, you have an area of brightness in the centre of the room, which throws the surrounding portions into comparative darkness, although they may be illuminated to an extent which without the brilliant contrast would appear sufficient and satisfactory.

Before discussing the question of the factors necessary to give satisfactory illumination, it will be well to glance at the photometric methods at present in use practically for measuring the illuminating value of the gas. Many methods of doing this have been from time to time suggested, and from the time of François Marie's attempt in 1700 to measure the illuminating value of flames by trying how many pieces of smoked glass had to be placed in the path of the rays in order to entirely cut them off, down to the present day, a large number of different expedients have been proposed.

All the photometers, however, now practically in use for official gas testing date from 1843, when Bunsen first introduced the idea of measuring the relative intensities of light by equally illuminating the two sides of a piece of paper with a grease spot in the centre, and then calculating the relative intensities by the distances at which the opposing sources of light had to be placed from the screen.

The principle of Bunsen's method of measuring the equality of light is that if a portion of a sheet of paper be waxed, the portion so greased is more translucent to light than the portion which has not been so treated, and consequently when a light is placed on one side of the paper, the portion which has been greased stands out in a very marked manner as a bright spot on a dark ground. If now a second source of light be placed on the opposite side of the paper, the grease spot will appear bright on the side opposite to that on which the strongest light is placed. If, however, the two lights are so arranged that each side of the paper is equally illuminated, the grease spot will practically disappear, or the spots on the two sides will appear of the same brightness. The Bunsen disc made on this principle consists at the present time of a circle of ungreased paper in the centre of a waxed disc. These discs are made by mounting them on a thin steel axle revolving at a high rate of speed; during rotation a vessel containing wax dissolved in a volatile solvent is brought in contact with them, the paper being submerged in the liquid to a suitable depth, the result being that a small circle of paper remains unwaxed in the centre of the disc. The excess of solution being removed, and the solvent allowed to volatilise off, the discs are taken off the spindle, and are ready for use.

Besides the Bunsen disc with the plain circle, another variety known as the Leeson, or Star disc is sometimes employed. In this disc two pieces of paper are fixed one on either side of a thicker piece of paper, out of the centre of which a star-shaped piece has been cut. Difficulty was at first experienced with this disc, as the thin paper was apt to warp and so present an uneven surface, but this drawback was overcome by Mr. Dibdin, who fastened the papers together with thin starch water and dried them under pressure, and in this way the warping and buckling of the paper was avoided.

The Bunsen disc has the disadvantage that when two lights of different colour are under trial, it is very difficult to find when the disc is equally illuminated, but the Leeson disc does not present this drawback in so marked a degree, and lights of a different tint can be compared with much greater ease.

A peculiarity sometimes met with even in discs of the best construction is that the sides give somewhat different readings, consequently this may lead to the introduction of grave errors. If, however, during the tests the disc is reversed and one-half the readings taken with it in each position, by taking the mean of the two sets of readings this error will be practically eliminated. If the discrepancy on reversing should be very great, the disc must be discarded, and in every case the surface of the disc used must be protected from dirt and dust as much as possible, as the greasy surface is able to fix dust on it, and a new disc must be employed when the old one shows any sign of discolouration or irregularity in working.

After the introduction of the Bunsen disc, photometers began to be made in various forms. The first instrument consisted of an open bar 100 inches in length, and the disc was fixed in a frame which could be moved backwards and forwards along the bar. At one end of the bar the standard burner was placed and at the other end was the candle. Dr. Letheby fitted the disc in a small box open at the ends to the sources of light, an opening being made in the front of the box to allow the observer to view the disc, which was placed in the centre of the opening at right angles to the line of sight and between mirrors placed at such angle that the two sides of the disc could be seen at the same time by the observer standing in front of the box. In place of the single candle two flames were employed, these being obtained from two halves of the same candle. The candles used for gas testing being moulded candles are slightly tapered in order to facilitate their removal from the mould in which they are formed, and accordingly the quantity of sperm consumed as the candle burns will constantly be altering. If the candle be cut in half and lighted at the middle, one half will burn down to the thick end whilst the other burns to the thinner end, thus the differences in the diameter will be compensated for. The candles are suspended in a holder on a small balance, so that the amount of sperm consumed during the testing can be accurately determined, and existing regulations only admit of those candles which consume more than 114 or less than 126 grains of sperm per hour as being "standard candles." The length of the bar was also reduced by Dr. Letheby from 100 to 60 inches, which may or may not be an advantage according to the state of the atmosphere. On a 100-inch bar the length of travel for the disc was considerably larger for the alteration of illumination than on a 60-inch bar, and for this reason the 100-inch bar was an advantage. But in foggy weather, or in an atmosphere containing a large amount of suspended matter, it is evident that the longer the bar the greater will be the interference of the atmosphere with the amount of light falling upon the disc. But if the standard and the light to be tested are nearly of the same value, the chance of error due to this source will be greatly reduced, in which case more accurate determinations could be obtained from the 100-inch bar.

The "closed Evans" photometer was introduced in 1858. It consisted of a large box enclosing the candles and the light to be tested, and differed from the former "open bar" photometer in the disc being fixed, and the candles being mounted on the balance which travelled backwards and forwards by means of an endless cord attached to a small winch. This form of photometer was designed for open-air testing, and every precaution had to be taken against draughts affecting the candles or the gas flame. Its introduction into the photometer rooms was a mistake, as the want of thorough ventilation and the heating effects of the walls of the box upon the larger flame caused the results to be slightly in favour of the latter. This objection was, however, partly overcome by improving the ventilation at the two ends at which the candles and gas are burning, as is done in the "tower photometer," but where a darkened room can be obtained, the "open bar" is undoubtedly the best, as the smallest check to the free passage of the air to the flame causes slight variations in combustion, and a corresponding influence upon the light emitted by the flame, and the tendency being to act upon the smaller flame more than upon the larger, the results cannot be relied upon.

The question of the standard light by which the value of the coal gas is to be tested in the photometer has been so fully discussed within the last year before the Society, that it seems hardly worth while to again go deeply into the matter. I will, therefore, only roughly indicate the propositions which have been made during the past forty-five years, and the present state of our knowledge on the subject.

The candle has been recognised as the legal standard ever since its introduction by Bouguer as a unit of light, but the results which are obtained from it in practice do not in any way attain the scientific accuracy which ought to prevail, and whilst the standard does not yield accurate results, it is of little avail to try and attain perfection in the remaining portions of the apparatus used for testing the quality of the light. Wax candles were first enacted to be employed for gas testing in 1850, before which date there had been no definition as to what candles were to be used, but in 1866 these gave way to sperm candles, of six to the pound, and burning 120 grains of sperm each per hour, and the light yielded by these candles was a little more than that obtained from the previous wax candles—fourteen sperm candles being equal to sixteen wax ones. Pure spermaceti, owing to its crystalline character, and consequent brittleness, could not be used alone in practice, and accordingly the sperm was mixed with 4 to 5 per cent. of beeswax, and great care has to be taken to get the quality of the sperm and the proportions of the mixture uniform. The wick is, however, the weakest point, a slight variation in the roughness or texture of the material, in the preliminary treatment of the fibre, or the twist of the thread or the tension during plaiting causing great alterations in the light emitted by the candle.

All the various committees that have been appointed to consider the question of a reliable standard of light have unanimously come to the conclusion that the sperm candle cannot in any way be regarded as an accurate standard. Nevertheless the candle holds its own as the legal unit of light, owing largely to its convenience and the difficulty of providing another standard which shall be as handy to use, and which will be more reliable under ordinary circumstances.

To obviate the inaccuracies of the sperm candle many attempts have been made from time to time by the Gas Referees to ensure more uniform results. The candle was first of all to be lighted at least ten minutes before the test was made, at the end of which time the wick was to have a glowing tip at the end of a slight bend, as, when this condition is attained, the candle will be burning at its normal rate. Later on it was prescribed that all testings were to be rejected in which the consumption of the sperm was more than 126 or less than 114 grains per hour. In 1889 the relative positions of the candles and their wicks were clearly defined, and the observer was further directed to employ a fresh candle for each test, whilst in September, 1894, minute regulations for securing, as far as possible, uniformity in standard candles by attention to the material and treatment of the wicks and sperm were added to the Gas Referees' instructions, and all the candles issued for official gas testing in London are at present examined and certified for use by them.

In spite of all these precautions, however, the candle still remains an unsatisfactory standard, and in consequence many other forms of standard have from time to time been suggested, amongst which may be mentioned Keate's lamp, introduced in 1869, which was practically a modified form of the "Moderator" lamp. This lamp, when burning sperm oil at the rate of 925 grains per hour with a 2-inch flame, yielded a light equal to sixteen candles. This lamp was modified by Mr. Sugg, who added to it what was practically a Methven slot, and it then gave more constant results than had been obtained from candles, but its general performances were not good enough to warrant its adoption. The French standard of light is the Carcel lamp, dating from 1800, which burns refined colza at the rate of 42 grammes per hour, the light given equalling 9·5 English candles. The standard due to Herr Hefner Alteneck consists of a lamp burning the vapour of amyl-acetate, the wick being contained in a round tube of German silver, 8 mm. in diameter and 25 mm. high, and regulated so as to produce a flame 40 mm. high. This lamp ought to yield a light equal to one candle, but Mr. Dibdin found that the flame had to be increased in height in order to equal the light emitted by the Methven screen per candle. The red colour of the flame, which renders the task of comparing the light to be tested a difficult one, is the great drawback to this standard. Another standard was proposed by Violle, but its impracticability rendered its use impossible, as he proposed to employ the light emitted by one square centimetre of platinum at the point of fusion.

The Methven screen, first introduced in 1878, is one of the most convenient forms of standard that has been proposed, and is largely used at the present day in gas works. It consists of an upright metallic plate fixed in front of a London argand. This plate has an opening which is covered by a slotted silver plate, the opening of which is of such size that an amount of light equal to that afforded by two average standard sperm candles is allowed to pass through when the gas flame is three inches in height. It is only within certain limits that one can get a constant light from a small portion of a gas flame, and although these limits are well within the illuminating value of the London gas supply, it is better to obtain greater constancy by using an aperture of smaller area and carburetting the coal gas with pentane.

The standard proposed by Mr. Vernon Harcourt in 1877, and described at the British Association meeting in that year, was an entirely new departure. The burner consists of a brass tube 4 inches in length and 1 in diameter, the upper end being closed by a brass plug half an inch thick, in the centre of which is a round hole one quarter of an inch in diameter. A glass cylinder, 6 inches by 2 inches, surrounds the tube, the top of which is level with the top of the burner. At a height of 62·5 mm. above the burner is stretched a piece of platinum wire, 2 to 3 inches long and about 0·6 mm. thick. The air which has been carburetted with the pentane is passed through a small meter which registers one-sixth of a cubic foot at each revolution, and then through a governor which regulates the supply to half a cubic foot an hour. The height of the flame is so adjusted that it appears to touch the platinum wire, but not to pass it, the platinum being fixed directly above the flame, and extending half an inch on either side of it.

A special gas is used in this burner, and it is made by mixing in a gas holder air and liquid pentane in the proportions of 1 cubic foot of air and 3 cubic inches of pentane. The pentane is obtained from light petroleum, which is distilled at 60°, 55°, and twice at 50° C., and has to answer to the test of only faintly colouring one-twentieth of its own bulk of fuming sulphuric acid on agitation with it for five minutes. The density of the liquid must be between 0·62 and 0·63 at 62° F., the liquid must volatilise at ordinary temperatures without leaving any residue when the tension of its vapour is not less than 7·5 inches of mercury. Its vapour density as compared with air must be not less than 2·47 or greater than 2·53.

The chief drawbacks to this standard are that the personal equation of the observer affects this unit of light to a considerable extent, it being difficult for two observers to fix the flame at the same height, whilst the flame is also largely affected by vibrations and draughts.

After all the endeavours to obtain a standard burner which shall emit a constant light of small intensity, the opinion is generally gaining ground that it is preferable to employ a standard light which shall nearly approximate to that yielded by the flame undergoing comparison. Mr. Dibdin has devised to meet this requirement, a 10-candle pentane argand which consumes gas carburetted with pentane, or a mixture of pentane vapour and air similar to that employed in the Harcourt unit. The argand burner is of special construction, giving a very full bodied flame, the top of which is cut off by a screen, exposing a fixed height of flame. This burner, from the constancy of the results obtained by its use, its ease of manipulation, and the small extent to which it is affected by external causes, is the standard recommended by the Photometric Committee of 1891-94, but its adoption in the place of candles has not yet been effected.

Coal gas, during the testing of its illuminating value, has always to be burnt at a fixed rate of flow, 5 feet an hour, and this acts very well within certain limits of illuminating power, but if the gas fall below 15½ candles, it has a very prejudicial effect on the results obtained. The height of the flame also is an important factor, as the size of the chimney is calculated to supply the correct amount of air for a 3-inch flame, and if a shorter flame is being tested, combustion is overdone, with the result that a depreciated reading is obtained. If, however, the gas be richer and the flame consequently longer, a false record will again be the result, as an insufficient supply of air is brought in contact with the flame.

It is evident from these considerations that both the photometers and standards in use are capable of considerable improvement, whilst another source of error exists in the fundamental method upon which all such measurements depend.

When the distance of the flame to be tested and of the standard have been so arranged that the disc is equally illuminated on both sides, the illuminating value is found by taking the ratio existing between the squares of the distances at which the light emitting sources have to be placed from the disc. The law of inverse squares upon which this procedure is based may be stated as follows :—" If the medium through which the light is passing be transparent, the intensity of illumination which a luminous point can produce on a white surface directly opposed to it, is inversely as the square of the distances."

It is manifest that this law will only be absolutely true when the source of light is a point, whilst in all photometric measurements the source of light to be measured consists of an area varying from 1 to 4 square inches in size, whilst the standard candle will give a far smaller area, and at first sight this appears as if it must be a grave source of error, but when the extent of this error comes to be mathematically calculated out, it is found to be excessively small as compared with the errors introduced by bad forms of photometers and faulty standards, as whilst the standard and the light to be measured are at a reasonable distance from the screen, the error introduced by an extended area instead of a point is extremely small, and will not affect the accuracy of the results to any appreciable extent, unless one or other source of light be brought within a distance of 7 inches from the screen; but directly, however, this limit is reached, the error increases with such enormous rapidity that the results obtained would have to be discarded, and this is one reason why it would be far preferable to test a flame by a standard which as nearly as possible would approximate to it in size, as in this case the error due to this factor would disappear. This is a strong argument in favour of adopting the Dibdin 10-candle standard, as the one by which the illuminating power of the London coal gas as determined in the London argand should be tested.

Attacks have from time to time been made upon the use of the law of inverse squares, but there is no doubt that for all practical purposes, it may with safety be used photometrically with the above reservations.

It must, however, be apparent that as the source of light is neither a point nor a uniformly illuminated surface, the amount of light emitted by a flame will probably vary considerably according to the angle at which the rays are falling, and that this is so was pointed out by Mr. Dibdin some years ago.

It must also be borne in mind that the photometer only measures the relative intensity of the direct rays emitted by the flame, every precaution being taken to shut off reflected light, whilst in the lighting of a room the light reflected from the walls and ceiling plays a very important part, and the amount of light reflected by the object on which it falls will also vary with the angle at which the rays strike the object.

The result of this is that although the values recorded by the photometer give a ratio of value for the direct rays falling on surfaces in the same horizontal plane as the source of light, they tell us absolutely nothing as to the combined value of the direct and diffused light cast upon our book or any working surface, which, as a rule, will be at angles varying from 45° to 90° below the flame.

The direct rays are those which, radiated from the luminous source fall directly on the object illuminated, whilst diffused light consists of those rays which have been reflected from one or more surfaces, or which have been refracted by passage through media of varying density, and as photometry only deals with the primary source of illumination, and that, as a rule, only on the horizontal plane, it is absurd to suppose that such recorded illuminating values can have any value as indications of the illuminating effect arrived at in practice.

The ordinary classes of burners in domestic use for the consumption of coal gas are the argand, the flat flame, the regenerative, and the incandescent. The London argand may be taken as a type of the first, the union jet and batswing of the second, the Wenham, Siemens, and Cromartie, of the third, and the Welsbach and Sunlight mantles of the last class.

These burners were all carefully tested upon Dibdin's radial photometer in a darkened room in which all objects were carefully blackened so as to ensure absorption of all rays not falling on the disc, and the Table on page 5 records the results obtained, reduced to candles per cubic foot of gas consumed at all angles from the horizontal down to the vertical.

In an ordinary dwelling-room the gas lights are, with very few exceptions, so arranged as to be above the line of sight and so avoid irritating the eye, and a moment's observation will convince anyone that the illumination shed upon our book or writing is derived from a source of from 40 to 90 degrees above it, and it is manifestly the illumination given by the burner between these angles which is the important factor in domestic lighting.

On now turning to the Table showing the results given by various burners at angles from the horizontal to 90°, the inferiority of the standard London argand at once becomes apparent, as at an angle of 60° it is surpassed in illuminating value by even the small flat flame burner, and the rule of thumb practice,

TABLE I.—ILLUMINATING VALUE OF VARIOUS BURNERS AT ANGLES BELOW THE HORIZONTAL, IN TERMS OF CANDLES PER CUBIC FOOT. (16-CANDLE GAS.)

Angle.	Name of Burner.						
	London Argand.	Union Jet.		Batswing.		Regenerative.	Incandescent.
		No. 5.	No. 7.	No. 5.	No. 7.		
Horizon.	3·2	1·67	2·09	1·90	2·43	3·4	16·6
10	3·19	1·67	2·08	1·84	2·42	4·8	16·6
20	3·07	1·55	2·03	1·73	2·38	5·3	16·1
30	2·72	1·45	1·88	1·61	2·25	5·8	11·1
40	2·38	1·40	1·64	1·47	2·18	6·0	8·8
45	2·18	1·30	1·50	1·38	2·12	6·2	8·0
50	2·12	1·27	1·50	1·38	2·05	6·5	6·6
60	1·20	1·23	1·50	1·30	2·07	6·7	2·0
70	unreadable	1·23	1·37	1·23	2·00	7·7	unreadable.
80	,,	0·76	1·25	0·76	1·75	8·0	,,
90	,,	0·30	0·87	0·76	1·37	8·0	,,

which has made the flat flame burner the popular method of illumination, is fully justified as long as we have only the flat flame and the argand to choose between, whilst when we come to high-power lights such as the regenerative and the incandescent, we find that the latter, in spite of its overwhelming superiority in horizontal rays, is only equal to the regenerative when the working angle is reached, whilst below 60° even the flat flame burners surpass it in illuminating value, and the regenerative burner shows out for the general illumination of a room as still superior to any of its compeers, as with horizontal rays equal to the London argand, it gradually gathers in illuminating strength the lower the angle becomes, until upon the table immediately below the burner a full flood of light is shed.

These results were obtained as before mentioned, in a darkened room, the objects in which were blackened to prevent reflection, and therefore represent the direct rays only and allow nothing for reflection, and it will be justly argued that with such intensity of light as is given by the incandescent mantle, the reflections from the highly-lighted portions of the room would compensate for the loss of direct rays in the downward direction. In order to see how far this might be so, a fresh set of tests was made between the angles of 45 above and 45 below the horizontal, first in the darkened and blackened room and immediately after with the same mantle in a room with light distempered walls and white ceiling, care being taken to prevent light escaping into the room from the standard burner used, and under these conditions the following results were obtained :—

TABLE II.—CANDLE POWER PER CUBIC FOOT.

Angle.	With blackened ceiling and walls.	With light ceiling and walls.
45	8·75	11·23
40	9·72	11·80
35	11·28	13·26
30	12·25	14·90
25	13·22	15·01
20	13·60	15·30
15	14·58	15·53
10	14·97	15·71
5	14·97	16·13
Horizontal.	14·97	16·34
5	14·58	16·34
10	13·60	15·93
15	12·43	14·30
20	11·28	13·26
25	10·69	12·60
30	9·72	11·23
35	7·78	10·21
40	6·22	9·19
45	5·05	8·60

In these experiments it will be noticed that the mantle used gave a slightly lower illuminating value than the one employed in the previous set of experiments, but as the same mantle was used both in the darkened room and in the normal room, the results obtained may be taken as a true indication of the effect due to reflection for this particular source of light, which being exceptionally intense gives a much larger per-centage of general illumination from this course than would be the case with lights of less intensity.

It will be seen that in the horizontal plane the increased effect due to reflection is comparatively small, and only amounts to 9 per cent., whilst at 45° above reflection increases the illumination by 28 per cent., and in the downward direction the increase at 45 amounts to no less than 70 per cent. This result, however, might be expected when one considers how much greater the reflective power of a white ceiling is than of the boarded floor. The difference would of course be far greater with dark furniture and carpeted floor, which would reduce the reflection, helping the upward rays to a minimum, whilst the downward reflection would remain practically the same.

With feeble sources of light in a fair-sized room, the increase of light due to reflection becomes also negligible, and on making an experiment with the London argand under the same conditions as those used with the incandescent mantle, it was found that the increase given by the light walls and white ceiling was only 3 per cent. on the horizontal, and 1 per cent. at an angle of 45°. In practice this trouble has been to a great extent met by the use of reflectors and globes of special construction, the results of which will be discussed in a future lecture.

It is evident from these experiments that where the illumination is required for the table, the regenerative burner immediately above it gives by far the best results, whilst the flat-flame burner is still the one best adapted for use in chandeliers.

If, however, the general illumination of the room is aimed at, the incandescent mantle may be employed, but must be attached to brackets on the walls of the room, and not used in overhead chandeliers.

Whilst admitting the usefulness of photometric observations on the horizontal plane as giving a basis for legislative enactments as to the quality of an illuminating gas supplied to a town, I think the time has now arrived for a more general recognition of the fact that the values so obtained are useless as giving any indication of the light which a consumer may expect to develop from it, a plan which Mr. Dibdin made ten years ago, but which has been entirely disregarded.

The so-called 16-candle coal gas supplied to London is made to yield on the horizontal plane anything from 8 to 80 candles of illumination, according to the burner used for its consumption, whilst at the angles ordinarily employed, startling modifications of these figures again take place. With most burners the light emitted at an angle of 45 remains fairly constant up to an angle of 60, and I think it would be a valuable step forward if in comparing the light emitting value of various burners the light radiated at the working angle of 45 were always employed instead of the misleading results obtained on the horizontal plane.

This I think is one of the chief causes also of the discrepancies existing between illuminating power and illuminating effect, but other factors less easy to deal with are :—

The difference in effect caused by the variations in the size of the source of light; the effect of distribution and intensity of the sources of light on the visual organs; and the reflecting power of the surrounding objects.

The size of the source of light has an important influence on the illuminating effect. If a large flat coal-gas flame, and a small high-power oil gas or acetylene flame of the same illuminating power, be placed at equal distances from a rod, and the shadows of the rod be then received on a white screen placed at some distance from the rod, the shadow due to the large flame will be seen to have soft, undefined edges, whilst the shadow from the small flame will be sharp and hard, so that although in each case the depth of shadow may be equal, the one will be far less striking to the eye than the other, and this causes the illuminating effect of the large flame to be better than that given by the small flame. Another important point is that the larger the surface from which the given amount of light is being emitted, the less will be its intensity for any given area, and the less the deadening and irritating effect upon the optic nerve.

The smaller and more intense the light-emitting source, the greater will be the contrast between the highly illuminated area immediately surrounding it and the less well-illuminated portions of the room at a greater distance from the source of light, and which to the eye fatigued by the intensity of the central illumination appears almost in darkness.

The best form of illumination for the living rooms of a house is undoubtedly to have the source of light so placed as to be well above the plane of vision, and yet sufficiently intense to flood the room with soft light, and it is the possibility of obtaining this with ventilating regenerative burners fixed in the ceiling which renders this form of illumination at once the best and most healthful that can be used for our dining and sitting-rooms.

It is only the ventilating form of these lamps, however, to which this applies, as, if a non-ventilating regenerative lamp is employed, it comes too far down in the room to be fit for use in any but an unusually lofty apartment, as, under ordinary circumstances, the heat which they throw out is a serious drawback to their use.

Where structural or other considerations prevent the use of such ventilating lamps, the great aim in effective lighting should be to subdivide the source of light as far as possible, as in the same way that sixteen candles scattered about a room give a far more effective illumination than one 16-candle argand burning in the centre of the room; so, in a large space twenty 14-candle flames give a far better effect than ten 28-candle flames, and these latter again surpass one centre of light yielding 280 candles.

If it is desired to use small and intense centres of light such as are given by incandescent mantles or acetylene flames, then, not only for the sake of illuminating effect, but also for the sake of our eyesight, we must adopt means for diffusing the intensity of the light source over a larger surface, which shall itself become the light-emitting centre, and the means of doing this will be discussed when we come to consider the effect of the various forms of globes in use.

Illuminating effect not being due to any one factor acting alone, but the combined effect of at least four, one or more of which vary with the particular environment as well as with the source of light, can only be measured where it is produced, and no calculations can give even an approximation as to the result.

Instruments for the measurement of the amount of illumination received at any point have been devised by Preece, Mascart, Trotter, Sugg, and others, and have yielded valuable data, but our knowledge is still too incomplete to allow of any very definite laws being laid down.

In the spring of this year some interesting experiments were made by Major G. K. Scott Moncrieff on the suitability of the various burners commonly in use for the illumination of the interiors of barracks and other buildings of a similar nature.

He takes as a starting point the fact that it is possible to look up a train in Bradshaw with a light of 0·16 of a candle foot, provided the eyesight be good, and that therefore 0·2 of a candle foot is sufficient for any ordinary work of a character likely to be done after dark.

Experiments were then made in a soldiers' barrack-room, 40 feet long by 20 wide, and the source of light having been fixed 8 feet above the floor, the illumination on a horizontal plane 2 feet above the floor was determined by a specially constructed photometer.

The height of 2 feet was fixed upon as being the height of a man's knees when sitting on a chest or cot, and the lowest level at which printed matter would be read, and the area of the portion of room on that plane at which the illumination was 0·2 or higher was taken as satisfactorily illuminated. The practical results of the experiments are shown in Table III. (p. 98), and the conclusions arrived at are:—

1. That the present illumination by means of No. 5 Bray burners is wasteful of gas and inefficient as regards illumination.

2. For barrack - room use, however, the common Bray burner may be retained if used with caps and grouped as in the "Stott-Thorpe" arrangement. This may in some cases be extravagant in gas, but the illumination is good and the arrangement is not easily damaged, and ventilation is assisted.

3. For reading-rooms, sergeants' messes, officers' messes, and other accessory buildings, the incandescent light is the best illuminant.

4. For places where the light source is some height above the floor, as in gymnasia, lecture halls, churches, regenerative lamps give very satisfactory results.

Every interior requires the illumination to be arranged for the special purposes in view—for the dining-room the illuminant must give a soft flood of light on the table, and yet be sufficient to light the side-board and the floor space. In the work-room or the office a strong local light is required on the bench or desk, and the remainder may be subdued light, whilst the sitting-room calls for a uniform illumination that shall light up the pictures and cornices, as well as the tables and floor.

In all cases the source of light should be well above the eye level, and to my own taste

TABLE III.—ILLUMINATION OF A BARRACK ROOM, 40 FEET BY 20 FEET, AT A HEIGHT OF 2 FEET FROM THE FLOOR.

Name of Burner.	Total Gas Consumption per Hour. Feet.	Illumination.
2 Bray burners	16	Whole room insufficiently lighted, nowhere possible to read small print 6 feet below gas lamp.
2 Flat flame burners fitted with caps	11·4	About one-quarter the working space illuminated.
2 Stott-Thorpe reflex lights	18	Eight-tenths of working level efficiently lighted.
2 Sugg's workshop lights	16	About one-quarter the working space efficiently lighted.
Siemens' regenerative	11	Whole room well illuminated.
Deimel regenerative	9	Two-thirds working space efficiently lighted.
2 Schulke lamps	10	Practically whole working space illuminated.
Welsbach incandescent, with glazed conical reflector	4·3	Whole room brilliantly lighted.

nothing can be better or more heathful for dining and living-rooms than the ventilating regenerative burner, whilst as bracket lights incandescent gas burners of a warm tint, such as the Sunlight, may be effectively employed. In the bedrooms man dare not dictate the form of illuminant, and the convenience of flat flame brackets for heating curling irons will probably ensure their supremacy, but whatever be the method of illumination, avoid intense centres of light and harsh shadows if you desire a proper illuminating effect.

NOTE.—A most excellent treatise on "The Science and Practice of Lighting," by W. H. Y. Webber, will be found of the greatest value by all interested in this subject.

Miscellaneous.

EGYPTIAN COTTON CULTIVATION.

Some interesting information is given in a recent issue of the *Bulletin du Ministère de l'Agriculture* respecting the different descriptions of cotton which have been successively cultivated in Egypt. The first cotton cultivated in the delta of the Nile was called *Jumel*, after the name of the person who introduced its cultivation, in the reign of Mehemet Ali, in 1820. M. Jumel, who was a Frenchman, had remarked in the garden of one of his friends living near Cairo, certain cotton plants, of which the seed had been imported from the Soudan. He succeeded in cultivating the plant from seeds which he obtained, and presented certain of them to Mehemet Ali, who, foreseeing the sources of wealth that the cotton might assure to the country, placed at the disposal of Jumel vast extents of territory, and gave him every facility in his enterprise. This cotton was also known by the name of *Mako*, after a bey in whose gardens Jumel had originally found the first seeds. *Jumel*, or *Mako*, was for many years the only cotton cultivated, but for a time it was replaced by a new variety called *Ashmouni*. This *Ashmouni* degenerated after twenty years of cultivation, and was abandoned for *Mit-Afifi*, which at the present time is the most largely cultivated in Egypt. *Mit-Afifi* is a very strong variety of cotton, easy to grow, and does not require any very excessive irrigation. The colour is slightly yellow, and is much appreciated by spinners. Another kind of cotton called *Bahmieh* is grown to a limited extent, and this is a delicate variety requiring a stronger soil. It yields a whitish cotton, which is particularly used for certain articles of hosiery. It enjoys a great reputation in the United States, while France and Germany consume small quantities of it. The cultivation of the varieties called "white cotton" has very considerably fallen off. Their total annua production hardly exceeds from 60,000 to 70,000 quintals. Many other varieties, such as *Zafivi*, *Abbassi*, &c., have been experimented with by many growers, but up to the present the results have not been sufficiently advanced to enable an accurate opinion to be formed as to their merits. Egyptian cotton, whatever its variety, preserves its essential qualities, which make of it a product much sought after by European and American specimens. As a matter of fact, no cotton, with the exception perhaps of Sea Island, the production of which is to some extent restricted, and the price too high to admit of its general and universal consumption, has the fineness, the strength, and the brilliancy necessary for the manufacture under good conditions of a large number of special articles. Egyptian cottons are used in making threads of the numbers 60 to 150, while Indian cotton makes threads of number 5 to number 18, and American cotton threads from 20 to 50. The qualities of Egyptian cotton are such that it finds a ready outlet on European markets, no matter what may be the production and prices of cotton of other origins.

PORTLAND CEMENT INDUSTRY IN BELGIUM.

The most important centre for the production of Portland cement in Belgium is the calcareous district of Tournai. Some of the quarries in this district date back several centuries, when they were principally worked for building stone, and for the manufacture of hydraulic lime. The calcareous stone of these quarries, which, according to the United States Consul at Brussels, originated the now extensive and important industry of cement manufacture, extends for many miles in length in apparently inexhaustible quantity. Ordinary lime, best hydraulic lime, slow setting (Portland) cement, and quick-setting (Roman) are especially products of these immense quarries. Consul Roosevelt says that natural Portland cement is obtained from calcareous stone which is carefully analysed and dosed, treated in coke-heated kilns, and after burning, finely pulverised. Analyses of the calcareous stone found at Tournai shows the following result :—Silicic acid, 15·75 per cent.; oxide of iron, 1; alumina, 3·95; lime, 43·1; magnesia, ·49; sulphuric acid, ·5; loss in firing, 35·21 per cent. Before burning the stone presents a fine close grain, and is of a peculiar pasty appearance. Prior to calcination the stone is carefully analysed to ascertain the exact quantity of lime as well as other chemical properties it may contain. The stone loses about one-third of its weight during the process of burning which also changes it to a brown tinge. When withdrawn from the kiln the cement is placed under sheds to thoroughly cool before being ground. After grinding, and before being packed into barrels, it is put into pits and left undisturbed for two months. Natural Portland cement was first produced in Belgium in 1882, and the establishments now engaged in the enterprise have formed a syndicate under the name of "Mutualité Commerciale des Ciments Belges," with headquarters at Tournai. The company sells about 1,200,000 barrels of cement annually. The syndicate has adopted as a trade mark the figure of a hammer. Any firm, however, of the syndicate, having a trade mark is privileged to use it. For instance, those firms having the well-known "rhinoceros," "trowel," "sword," &c., use them in conjunction with the syndicate trade mark. Independently of the trade marks of the manufacturers, important buyers of the Mutualité who have labels enjoying a certain reputation, are permitted to affix them on the barrels. It is stated that the principal object of this arrangement by the Belgian manufacturers is to warn and protect persons who purchase Roman cement for export without mark or label, and unknown and unauthorised by the manufacturers have Portland cement labels affixed to the barrels at the port of shipment. Roman cement is also made in the Tournai district. It is much cheaper than Portland cement, the selling price being about 50 per cent. less than the Portland. It is much employed in Belgium, replacing advantageously a good hydraulic lime. Manufacturers, however, will not guarantee it, as it is made of refuse stone not suitable for the manufacture of Portland cement. It has a natural light yellow colour. Cinders are very often added, changing it to a greyish colour resembling Portland cement, and also increasing its resistance in a slight degree. This is the product which is purchased by unscrupulous exporters and sold by them marked as Portland cement. This fact is significant and should attract the attention of builders, to avoid disasters such as the unexpected collapse of buildings where first class cement has been supposed to have been employed. Artificial Portland cement was first manufactured in 1872 by a Belgian firm — Messrs. Duffossez and Henry. There are now several important works engaged in its manufacture. Artificial Portland cement is the result of burning a thorough admixture of clay and carbonate of lime in constant proportions, and when dry reducing to finest powder. Several cements are manufactured by burning natural argillaceous limestone containing varying proportions of clay and carbonate of lime. Some manufacturers rectify the composition of these cements after burning by adding as required, limestone, slag, &c. Cements are thus produced, resembling in chemical constitution Portland cement, but which do not possess its properties, on account of the constituent elements not having been forced into combination by calcination and semi-fusion of the mass. These cements are sold under the name of artificial Portland cements, though in reality they are mixed cements, composed of limestone or slag, possessing none of the qualities or properties belonging to real Portland cement. Artificial Portland cement having an invariable chemical composition must necessarily present a constant character and behaviour, and the small differences shown by the assays arise generally from more or less perfection in the burning and grinding, but also exhibit radical changes in their physical and chemical constitution on account of the varying proportions of their component parts. Cement may be submitted to a large number of tests for the purpose of ascertaining its qualities. These tests relate to (1) regularity of composition; (2) fineness of grain; (3) gravimetric weight; (4) specific gravity; (5) time of setting; (6) resistance to tensile, compressive or shearing strains and cohesive strength, either when pure or mixed with sand; (7) uniformity of volume or expansion; (8) resistance to frictional wear; (9) expansion; (10) impermeability, &c. To be considered of good quality, the cement must give a satisfactory result to the group of tests to which it is submitted. Thus, if properly proportioned, it should, for a given fineness of grain, have a maximum of weight and specific gravity, fulfil the required conditions of setting, and show the minimum of resistance to strain required within a given time.

RAILWAYS IN CHILI.

Although Chili is still deficient in the important matter of easy, rapid, and economical means of communication and transport within her own borders, this question, which is of such great importance, does not appear to have been ignored by the authorities. According to a recent Chilian report, since the first railway was inaugurated in 1851, iron roads have multiplied, and railway extension has progressed to such a degree that the union of Valparaiso and Puerto Monti by rail has been brought within a readily measurable distance of time. The great trunk line has been prolonged from time to time, until it has been found necessary to divide it for the purposes of administration into three sections, to which there will probably be added, at no very distant day, a fourth. The first section comprises the line from Valparaiso to Santiago, and includes the branch from Las Vegas to Los Andes; the second comprises the line from Santiago to Talca, and include the Tinguiririca and Palmilla branch; while the third comprises the line from Talca to Victoria, and includes the Angeles, Traignen, and Talcahuano ramifications. The total length of the first section is 228 kilometres (kilometre = ·621 of a mile); of the second 296, and of the third 582, or a total of 1,106 kilometres. At the end of 1895, the condition of the state lines in course of construction was officially reported to be as follows:—Vilos, Illapel, and Salamanca, line of 102 kilometres in length, has suffered many delays, but the Cabilolen tunnel is finished as far as piercing is concerned. Work was also suspended for some time on the Ovalle and San Marcos line, but operations were recommenced on the Ovalle to Paloma section, and it has been finished. The Calera to Cabildo line is open for traffic to Palos Quemados. A considerable portion of the Talca and Constitucion line, the total length of which is 92 kilometres, is open for traffic. The Coihue to Mulchen line, 42 kilometres, has been completed. The Temuco to Pitrufquen line is being rapidly pushed forward, and the Pichi Ropulli line has been opened for traffic. Finally, surveys have been completed of several other lines.

General Notes.

Colonial Examinations in Music.—The Associated Board of the Royal Academy of Music and the Royal College of Music for Local Examinations in Music, has prepared a syllabus for Colonial Examinations in 1897. The examinations are conducted at local centres by an examiner appointed for the purpose by the Board. The Board is anxious to extend its examinations to all her Majesty's colonies, and wishes to undertake these provided a sufficient number of candidates is forthcoming to pay the expenses. It is already conducting examinations in the Cape of Good Hope, and it has representatives in Australia and Tasmania, where examinations will be held next autumn. The Local Examinations embrace (1) Practical Subjects (Pianoforte, Organ, Violin, Violoncello, Singing); (2) Harmony and Grammar of Music. Further information can be had from the office of the Associated Board, 32, Maddox-street, W.

Light Railways.—The proposal to construct a light railway between Alton and Basingstoke is, according to the *Engineer*, receiving support throughout the district which the directors of the London and South-Western Railway Company are most anxious to develop. On December 31st they will make application to the Light Railway Commissioners for a provisional order authorising the construction of the line. The proposed railway, after leaving Basingstoke, will pass through the parishes of Chiddesden, Ellisfield, Herriard, Southrope, Lasham, Bentworth, Shalden, Alton, terminating in the parish of Chawton by a junction with the company's Alton and Winchester line, at a point south of the Butts Bridge, carrying the line over the main road leading from Alton to Farnham. The proposed gauge to be adopted for the railway will be 4 ft. $8\frac{1}{2}$ in. If the Provisional Order is granted by the Commissioners the company will have the same power as had formerly to be obtained by Act of Parliament. Since the passing of the Light Railways Act of 1896, the Light Railway Commissioners have received many applications for the construction of light railways in various parts of the country, but this is said to be the first application proposed to be made by a railway company.

JUVENILE LECTURES FOR THE ENSUING WEEK.

Royal Institution, Albemarle-street, W., 3 p.m. Professor Silvanus Thompson, "Visible and Invisible Light." Lecture I., Tuesday, December 29; Lecture II., Thursday, December 31; Lecture III., Saturday, January 2.

London Institution, Finsbury-circus, E.C., 4 p.m. Professor J. A. Fleming, "Rays of Light: Old and New." Lecture I., Tuesday, December 29; Lecture II., Thursday, December 31.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 6 and 13, 1897, by Clinton T. Dent, F.R.C.S., Past President of the Alpine Club, on "The Growth and Demolition of Mountains." The lectures will commence at seven o'clock.

A sufficient number of tickets to fill the room have been issued to members, but a few tickets can still be supplied to such members as have not received any, if application is made at once.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

Proceedings of the Society.

CANTOR LECTURES.

THE USE OF GAS FOR DOMESTIC LIGHTING.

By Professor Vivian B. Lewes,
Chief Gas Examiner to the Corporation of the City of London, &c.

Lecture II.—Delivered November 30, 1896.

The history of our industries always impresses us with the great utility of brisk competition, and in no case is this more marked than in the utilisation of gas for the emission of light. From 1820, when Nielson of Glasgow first discovered the principle of the union jet burner and gave the world an easy and at the same time a fairly effective method of consuming the then newly introduced illuminant, until quite recent times, coal gas had been consumed by the methods which had sufficed for illumination in the early days; and in all probability the methods of consumption would have continued in the same inefficient groove up to the present time had it not been for the appearance of electric lighting as a competitor in the latter part of the seventies, and the dread which suddenly arose in the minds of those interested in gas manufacture as to the effect of this brilliant compeer on their commercial status. It is true that the germs of important methods of consuming gas had already been sown, but the time had not been ripe for their development, and it was only the absolute necessity of combatting the inroads of electricity that caused the adoption of new and improved methods for developing the light latent in coal gas.

In the early fifties Dr. Frankland had already pointed out that the heating of the air supply to a flame marvellously increased the light which that flame emitted, but it was not until Siemens, Clarke, and others worked the idea into practical form that we saw the completion of the regenerative or recuperative burner, which certainly marks the greatest advance ever made in the hygienic consumption of gas *per se*.

The fact that the luminosity of a coal gas flame depends upon the number of carbon particles liberated within it, and the temperature to which these carbon particles can be heated, at once points to the fact that the methods by which the light developed from a flame of coal gas can be augmented are the increase in the number of the carbon particles by increasing the material which will deposit them, or by raising the temperature to which the carbon particles already present have been heated, and whilst the first process is carried out by enrichment, the second is best obtained by regeneration, and it seems improbable that any great advance in the results already obtained in this direction is possible, as with gaseous enrichment it would be impossible to get beyond the results obtained from pure acetylene, and the action of regeneration is limited by the power possessed by the material of which burners are composed to withstand the superheating, and although with a perfectly made recuperative burner it might be possible for a short time to get as high a duty as 16 candles per cubic foot from the ordinary coal gas, such a burner constructed of the ordinary materials would only last a few hours, so that for practical use and a reasonable life for the burner 10 candles per cubic foot is about the highest commercial duty that could be reckoned on.

This limitation naturally caused inventors to search for methods by which the emission of light could be obtained from coal gas other than by the incandescence of the carbon particles contained within the flame itself, and the fact that a coal gas flame consumed in an atmospheric burner under conditions necessary to develop from it its maximum heating power could be utilised to raise particles having a higher emissivity for light than carbon to incandescence, led to the gradual evolution of incandescent gas lighting, which undoubtedly marks another of the most important eras in the history of gas as an illuminant.

Our present systems of lighting by means of incandescent mantles mark the perfection of many years of experimental toil and disappointment before the desired goal was reached, and from the day when Talbot, in 1835, first noticed that blotting paper soaked in a solution of calcic chloride and burnt in the flame of a spirit lamp leaves a white network of ashes, which heated in the feeblest flame emits a brilliant light, down to the latest developments of the Welsbach mantle, there have been many thousand of experimental failures and stillborn attempts, the records of which have neither seen nor created light.

That all solids can be made to emit light when heated to a certain temperature has of course always been known, whilst the fact that at any given temperature some substances would emit more light than others gave rise to the Drummond or lime light, in which a block of lime raised to the highest temperature possible by the intensity of the oxy-hydrogen or oxy-coal gas blast emitted a light which until the advent of the electric arc light remained unrivalled. The amount of material, however, which has in this case to be raised to incandescence rendered this very high temperature necessary, and it was gradually recognised that if instead of a block of lime, a basket work of thin filaments made of lime and magnesia could be employed better results would follow, as instead of the costly oxy-hydrogen or oxy-coal gas flame, an ordinary gas and air blowpipe working at a slight pressure could be used, and this was practically adopted in the Clamond mantle, which was probably the first oxide mantle which had any extended commercial being, and the same principle was utilised in the Fahnejelm comb, which was heated to incandescence by water gas.

The Clamond mantle, as shown at the Crystal Palace Exhibition of 1882-83, consisted of a conical basket composed of threads of calcined magnesia, which were formed by making a mixture of the hydrate and acetate of magnesium, converted into a paste or cream by means of water, and then moulded and ignited, the heat decomposing the acetate, which in its partial fusing during decomposition formed a luting material which glued the particles of magnesic oxide produced into a solid mass, whilst the hydrate gave off water and became oxide. The basket was supported with its apex downwards in a little platinum wire cage, and a mixture of coal gas and air was driven into it from an inverted burner above it.

Long before this oxide mantle, however, made its appearance, Lewis had introduced a mantle made of fine platinum wire, which raised to incandescence by a blast of air and coal gas gave for a certain period what was then considered a very high duty for gas consumed, but the rapid falling off of its power of emitting light proved a fatal obstacle to its commercial success. This deterioration was due to the surface of the platinum becoming eroded, partly by the formation of traces of carbide of platinum from the action of the hydrocarbon in the flame, and partly by the deposition on its surface of traces of foreign metals due to the breaking up of carbonoxyl compounds, of which the gas contained minute quantities, and this trouble it was which at a more recent date militated against what at first appeared a very promising attempt to utilise thin platinum-iridium wire for the manufacture of an unbreakable incandescent mantle.

Leaving these forerunners of our modern systems of lighting we come in 1886 to the first appearance of the Welsbach system of incandescent mantles, which after nine years of struggle and effort has at length attained a well-earned and phenomenal success.

Dr. Auer von Welsbach, whose researches on the rare metals and their compounds had already gained him a great reputation, conceived the idea of making a mantle of refractory oxides by the processes which had been previously shadowed forth by Talbot and others. In order to do this he took an open fabric of cotton, steeped it in a solution of the nitrates of the metals of which he required the oxides, and then having dried it, burnt off the organic matter, whilst the heat of this process converted the metallic nitrates present in the interior of the cotton fibre into oxides which retained the form of the fabric from which the skeleton had sprung. Step by step improvements were introduced into the mechanical processes employed and into the combination of metallic oxides of which the incandescent material was formed, until a point has been reached, which as far as light emissivity is concerned, has never been equalled in the utilisation of coal gas.

The commercial success attained by the Welsbach mantle has naturally caused an enormous number of attempts to be made to improve upon the mantles as already in use, but although in some cases these attempts have shown considerable promise, the Welsbach mantle still remains at the head of affairs, and as legal decisions have given this system what is practically the exclusive right in this country to use the oxides of those earths which appear most fitted for yielding high emissivity, together with long life to the mantle, it is evident that their rivals must aim at obtaining a mantle which shall be free from some of the more glaring defects which the Welsbach mantle possesses; and in view of the great interest which the subject of incandescent lighting now affords, it will be well to discuss the direction in which possible improvements in incandescent lighting are to be found.

The first most essential portion of the incandescent gas apparatus is the burner, the flame from which must be itself non-luminous, as otherwise deposition of carbon on the material heated would rapidly bring incandescence to an end. Non-luminosity may be obtained either by using atmospheric burners in which the mixture of air and gas is made before combustion takes place, or by the consumption of coal gas in a sheet so thin that air can permeate it with sufficient freedom to render it non-luminous, the former of these methods being employed in nearly all systems of incandescent lighting, whilst the second is used in Paris in one form of the De Mare light fringe, which is heated by flat flame burners so small as to emit no light from the flame.

The large demand for atmospheric burners created by their extended use for incandescent mantles has done much to improve their manufacture and to bring out the factors which it is necessary to observe in obtaining the highest heat duty by the combustion of the gas, and one of the most promising directions in which this has taken place has been the gradual realising that in order to obtain the best results it is necessary to have the mixture of air and gas, not only in such proportions as to give the most perfect combustion, but also that the mixture itself shall be so perfect in every part that the molecules of the combustible flame constituents and oxygen with which they are to combine shall find themselves side by side in every part of the mixture when the moment of combustion arrives, as the intensity of the flame must of necessity be greatly increased by the proper regulation of this factor.

Perfection of mechanical mixing has long been recognised as an absolute necessity where equality of result and maximum effect have been required in such high combustibles as gunpowder, and the rough and streaky admixture of air and gas which takes place in an ordinary Bunsen burner is in much the same condition in regard to its effects as the powder produced by Roger Bacon, and in our burners in order to obtain the maximum effects we ought to aim at making our gas and air into as perfect a mechanical mixture as we find in the highly-finished powders of to-day. Attempts have not been wanting in this direction, and such burners as those introduced by M. Dennayrouze aim at doing this by mechanically churning together the gas and air before combustion, but such burners require a motor of some kind which renders them clumsy and costly, and it would be far better, therefore, if a successful method could be produced where the gas and air could be made to thoroughly mix in the right proportions without the aid of external mechanism.

In wading through the mass of literature dealing with the subject of atmospheric burners, one finds that in 1891 M. Chemin took out a patent for making a Bunsen burner in which the gas entering at the bottom passed up through successive cones, in each of which admixture with fresh portions of air took place, so that instead of the air being drawn in by the uprush of gas in the burner tube in one operation, as is the case with the ordinary Bunsen burner, the influx of air would take place in successive portions which tends to give a better mixation of the two; but this is not of itself sufficient to give any very great increase in the heating effect to be obtained from the burner. In the same way it has from time to time been proposed that the mixture of air and gas before combustion should be passed through shields of wire gauze, which, whilst preventing the flashing back of the air and gas at the nozzle of the burner, also helps in completing the mixture of the air and gas; but here again no increase was obtained until M. Bandsept, by combining these two principles and by making a head to the burner which should give a decreasing instead of an increasing resistance to the flow of the gas and air, and by making what he terms "Atomizers," consisting of several layers of wire gauze at the point immediately before combustion takes place, gets a far more complete mixation of the combustible gases, whilst his injection cones are so arranged as to give a maximum induction for a given pressure, and these being surrounded by a moveable outer casing perforated with small holes for the introduction of the air, enables him to obtain his air supply in a large number of small streams at a low pressure, and the effects produced by this burner are distinctly an advance upon any burner of the simple Bunsen type before made.

There is no doubt that this is the right direction in which to look for improvement in the consumption of gas and air, and experiments made by Mr. F. Livesey, of the South Metropolitan Gas Company, show that even when the mixture of gas and air made in an ordinary Bunsen is allowed to flow for some distance through a tube, increased heating effects may be produced by the mixture of the gases through diffusion during their travel together under conditions which equalise their pressure; but there is no doubt that with the gas travelling up the tube of a Bunsen at a more rapid rate than the air current which it induces, the velocity of the gas to a great extent prevents diffusion taking place in any great degree, with the result that as the mixture issues from the mouth of the burner it consists of slices of air and gas of different degrees of admixture rather than a perfect mixture of the two. Experiments made with the Bandsept burner have led to its adoption by the Welsbach Company in Paris, and the results obtained by reliable observers show that a very great gain in the duty of the mantles used with it is obtained.

My first impression on working with the Bandsept burner was that it would not prove as effective in England with the comparative low pressure of gas as had been found the case in Continental cities, where higher pressures exist, but extended experiments with the burner lead me to believe that there are great possibilities in its use.

In a Bunsen burner the chemical actions which give rise to the heating consist of two distinct combustions, the first taking place on the surface of the inner visible cone of the flame; and here the hydrogen and hydrocarbons of the coal gas undergo a partial combustion at the expense of the oxygen of the air which has been previously mixed with the coal gas and which results in the combustion of the carbon to a mixiure of carbon monoxide and dioxide, whilst some of the hydrogen is burnt to water vapour, the outer flame being produced by the combustion of the hydrogen and carbon monoxide escaping from the inner zone into the completed products of combustion carbon dioxide and water vapour.

The characteristic appearance of the Bunsen flame varies according to the amount of air which is allowed to enter with the gas, and under normal conditions the zones of flame have a violet blue colour, whilst as more and more air is allowed to enter with the gas, the flame becomes fiercer and the inner zone acquires a green tint, and a still further addition of air causes the mixture to become so highly explosive that it flashes back into the tube of the burner. During this change in the colour of the flame alterations are taking place in the temperature which the various parts of flame are emitting, and the following Table gives an approximate idea of the increase that takes place with the addition of more and more air and which reaches its maximum as an explosive limit is approached:—

TEMPERATURES OF BUNSEN FLAME WITH BLUE AND GREENISH INNER CONES.

	Blue Inner Cone.	Greenish Inner Cone.
Tip of inner cone......	1,090°	1,575°
Centre of outer cone ..	1,533	1,630
Tip of outer cone......	1,175	1,545
Side of outer cone, level, with tip of inner cone..	1,333	1,511

The ratio of gas to air in the blue and greenish non-luminous combustions is about—in the blue, 1 volume of gas to 2·27 of air, and in the green, 1 volume of gas to 3·37 of air.

The reason of this is that the less air that is supplied to the centre of the flame the more has to be introduced from the exterior, and whilst the interior supply has been heated by the passage up the hot tube and by partial combustion in the inner zone, the outer supply is cold, and as not only the oxygen which is used by the flame has to be heated, but also four times its volume of diluting nitrogen, it is manifest that the less external air that is sucked into the flame the higher will the temperature of the external portion of the flame become, and as it is this part of the flame which is utilised for heating incandescent mantles, it is clear that this will give a gain in the amount of light to be obtained from the mantle itself.

In the Bandsept burner it is possible to so regulate the mixture of the air and gas that not only is the green cone in the interior of the flame formed, but owing to the explosive point being reached, it is drawn down on to the surface of the top of the gauze forming the "atomisers" or mixers, through which, however, it is unable to pass, and the flame consists of what is practically only the outer cone of the ordinary Bunsen, and being fairly homogeneous has a greater equality in temperature than can be obtained with the ordinary flame.

Leaving the question of the burner by which the heating power of the coal gas is to be developed, we next come to the mantle, and in all the most successful forms this is made by taking a cylinder of cotton net 8 or 9 inches in length, which is puckered up and sewn together at the top with asbestos thread, a loop of the same material or of thin platinum wire being fixed across the constricted portion to form a support by which the mantle may be held by the carrying rod, which may be either external to the mantle or arranged as a central pin as is more often the case. Whilst the external support has the disadvantage of casting a shadow, the internal pin has the drawback of occasionally interfering with the combustion taking place in the interior of the mantle and leading to carbonaceous deposits.

The cotton net having been prepared in this way is then soaked in a solution of the nitrates of the metals, the oxides of which are desired in the finished mantle, and as each cotton fibre consists of a microscopic capillary tube, the liquid is sucked in by the action of capillarity until the tube is entirely filled, and when this point is reached further soaking is a drawback rather than an advantage, as most of these metallic nitrates have a distinct acidulous tendency which weakens the fabric of the cotton and renders it delicate in the handling before burning. The cotton having been soaked is then wrung out, and this gets rid of a good deal of the solution clinging to the exterior but does not affect the portion which has been taken in by the fibre itself. The cotton is then stretched over a conical mould and dried, after which it is ready for the process of burning off. This consists in burning away the organic matter and converting the nitrates present into oxides with evolution of oxygen and oxides of nitrogen. In doing this the heat of an atmospheric burner is first applied to the constricted portion at the top of the mantle, and the cotton burning partly at the expense of the oxygen of the air and partly of the oxygen from the nitrates, the flame spreads downwards, and the evenness and shape of the mantle to a great extent depends on the regularity with which this combustion takes place. During this portion of the action most of the fabric burns away, but leaves behind a certain amount of carbon which has to be burnt off by the judicious use of a blast blowpipe and atmospheric burner applied to the interior.

During the process of burning off the mantle you have a cellulose tube filled with the crystallised nitrates of the metals used, and as the cotton begins to burn the nitrates give up oxygen and become fusible nitrates, which in their semi-liquid condition are squeezed together and rendered coherent by the rapid shrinkage which takes place during the burning of the organic matter, and as the action continues the nitrates become oxides and rapidly lose their fusibility, with the result that by the time the last trace of organic matter has been burnt away, a coherent thread of metallic oxides is left in place of the nitrate laden thread of cotton.

In the early days of incandescent lighting no process was known of rendering the mantle of metallic oxides sufficiently strong to bear carriage, and the mantle had therefore to be sent out unburnt and had to be burnt off when it was required, but as the success of the mantle is almost entirely dependent upon the shape fitting the flame to which it is adapted, and as the burning it to that shape requires considerable practice, this was a very great difficulty, whilst another complication arose from the fact that the metallic nitrates were so acidulous in their nature that the mantles soaked in them quickly rotted away, unless after they had been soaked they were exposed to the action of ammonia gas, which converted any excess of acid into ammonium nitrate, but it was found that this so-called ammoniation rendered the mantles after they had been burnt even more fragile than before, and the reason of this is to be found in the fact that the ammonia gas converted the easily fusible and decomposible nitrates into hydrates, which were practically infusible, so that the pressing together into a coherent mass by the contraction of the organic matter on burning could not take place, and the mantle as often as not dropped to pieces as soon as it was burnt off.

It was therefore a great advantage when it was discovered that the burnt off mantle could be dipped in collodion, *i.e.*, a solution of soluble guncotton in a mixture of alcohol and ether, which, when the mantle is drawn from the solution, rapidly evaporates and leaves a thin film of collodion, so strengthening the skeleton of metallic oxides that they can be stored and sent from place to place without danger of fracture.

The oxides used in the first Welsbach mantles made in this country consisted of mixtures of zirconia, lanthania, and yttria, or zirconia and lanthania. Not only were these very fragile, but they only emitted from 4 to 7 candle-power per cubic foot of gas consumed. After gradual changes and modifications the composition of the present highly successful mantles is 98 per cent. thoria and 2 per cent. ceria, and the average performance of these mantles may be taken as being an emission of 16 candle-power for a consumption of 1 cubic foot of gas, whilst if the fragility of the mantle allows it to bring its life to a natural termination, they will last for a very considerable period, the light not showing any serious diminution during the first 500 hours, then gradually dropping away, until at the end of 1,000 hours it has lost about 40 per cent. of its original power of emitting light, but it must be clearly borne in mind that any such expressions concerning the life of a mantle is very misleading, as their fragile nature most frequently causes their premature demise from fracture, and if you took the life of a Welsbach mantle from the general average of all mantles sent out, it would be a great deal nearer 100 than 1,000 hours, as our personal experience with these beautiful but delicate fabrics teaches us that many more mantles are lost in the first 10 hours of their existence than are nursed up to a ripe old age of 1,000 hours.

Little is at present understood as to the causes which lead to the wonderful power of emitting light that these mantles possess, but I think there is little doubt that this must be due to some specific molecular changes which are taking place in the material employed, as unless this were so it would be practically impossible to find an explanation of the fact that the mantle of thoria alone emits practically no light, whilst the addition to it of 1-2 per cent. ceria excites the power of emitting light to the high degree found in these mantles.

If mantles are made from any one oxide alone no very startling illuminating power can be obtained, and the following Table shows the approximate value to be got from each oxide when used for mantle making by itself:—

Illuminating Value of Mantles made from the following Oxides per Cubic Foot of Gas.

Thoria—commercial	6·0
Thoria—pure	1·0
Zirconia—commercial	3·10
Zirconia—pure	1·5
Ceria	0·9
Yttria	5·2
Lanthania	6·0
Erbia—commercial	1·70
Erbia—pure	0·6
Alumina	0·6
Chromium oxide	0·4
Barium oxide	3·3
Strontia	5·5
Magnesia	5·0

Ceria gives a reddish-yellow light.
Erbia, zirconia, and oxide of barium, a yellow light.
Alumina, a whitish-yellow.
Strontia and magnesia, a white light.

From this it is seen that neither thoria nor ceria when pure have any particular power of emitting light, but mix with the thoria 1-2 per cent. of ceria, and at once the mixed oxides emit a light 14 to 16 times greater than either of the substances used, whilst on increasing the ceria the luminosity gradually drops until equal mixtures of the two give about the light we should have expected from the emissivity of the two constituents. It is generally accepted that the power of emitting light is dependent upon intense molecular activity in the luminous body, and it seems hardly probable that so small a trace of the ceria should have the power of setting up any chemical action which could induce luminosity, without the light-giving power being increased by the addition of more ceria, nor is it likely that the combination of so small a trace of ceria with the thoria should last over so long a period as that during which the mantle continues to emit light.

Some interesting experiments have been

made by Dr. C. Killing on the cause of luminosity in incandescent mantles, and his conclusions are that it is due to the catalytic action in a state of extremely fine division of the oxide which is added as an excitant to the skeleton formed by the chief material of the mantle, and he finds that traces of metallic platinum or iridium, or even gold, osmium, ruthenium, and palladium act in a similar way to the ceria added to the thoria mantles.

There is no doubt that if the skeleton of thoria be dipped into a dilute solution of platinum or iridium chlorides, small traces of these metals in an extremely fine state of division after heating will be formed on the surface, and that these will have a certain catalytic action, such as glowing when the gas is turned on to the mantle, but I do not think this is any proof that ceria and other oxides of the same character have a catalytic action of the same kind, even when at a high temperature, and I should certainly have expected that if the catalytic action was the true explanation of the phenomenon, further additions of the excitant to it ought to increase the incandescence, and certainly would not decrease it as is the case.

Dr. G. P. Drossbach has also made some interesting experiments on the light emissivity of the oxides, and he comes to the conclusion that when heated in a blowpipe flame, the light-emitting value of the separate oxides is found to be proportional to the formula—

$$\frac{\text{Molecular weight} + \text{Specific gravity}}{\text{Specific heat},}$$

but that with the heavy metals the oxides are gradually reduced and vapourised in the flame, and that these conditions alter if refractory oxides are introduced into the mantle with the reducible ones, as they behave as bases towards them, and allow the formation of compounds having the character of salts.

Another consideration is that ceria is by no means the only excitant that can be used to endow the thoria mantle with the power of emitting light, and it seems far more reasonable to suppose that the admixture of small traces of such bodies as ceria induce molecular changes in the state of the oxides, such as from the amorphous to the crystalline state, a change which may be excessively slow and which has before been observed to induce high incandescence when bodies capable of undergoing it are being heated.

Another example of the same character is to be found in the case of a mantle made of alumina, which emits no light, but which on being sprayed or dipped in chromic acid gives very good illuminating results. In this case, after an hour's heating, as far as chemical examination can tell, all chemical action has ceased, yet the power of emitting light continues for many days, and cannot therefore be due to the chemical action.

The colour emitted by the mantle varies greatly with the oxides of which it is formed, showing that specific alterations in the rapidity of the luminous vibrations are caused by alterations in the composition of the mantle. Nothing could be more marked than the difference between the warm pinkish-yellow light of the Sunlight mantle, which is due to the incandescence of oxides of zirconia and alumina, or alumina alone excited by oxides of chromium, and the cold greenish-blue light of the Welsbach mantle.

Lighting by means of incandescent mantles is now assuming such important dimensions that it behoves us to pay attention to every point in dealing with it, and it will probably be found that the colour of the light emitted by such combinations as those at present utilised in the Welsbach mantles will have a distinctly injurious action upon the eyesight when continued over any long period of time. My own opinion with regard to artificial illumination is that it is an absolute necessity in choosing a light by which we are to work that it should be essentially different from ordinary daylight, and should be as free as possible from those actinic rays which nature so largely utilises in sunlight for her chemical work. It is manifest that nature intended the eyes to be used during the hours of daylight, and that the strain on the optic nerve should be relieved by the periods of twilight and darkness. We can, however, without any great fatigue to those beautiful and delicate instruments, the eyes, continue to use them for some hours longer when the artificial light which we employ is of a soft character, and poor in actinic rays, such as is given by candles and oil lamps, or the gas flame, but I fear that when we continue to fatigue the eye with an artificial light, rich in violet and ultra-violet rays, that in the course of a generation or so the result of that fatigue of the optic nerve will begin to make itself manifest in the gradual deterioration of eyesight.

Very interesting experiments have been made by Professor Crookes on the difference in the light rays radiated by the Welsbach mantles and in the rays obtained from the Sunlight mantle. These mantles, when under experiment, were burnt in a chimney which had a window of quartz in it opposite the brightest part of the incandescent mantle, so as to allow of the free transmission of all ultra-violet rays of light, whilst the spectograph in which the spectra were photographed had a complete quartz train consisting of condensers, two double prisms, collimator and object-glass. Under these conditions photographs were taken on Edwards' isochromatic films, the experiment being carried out under such similar conditions as to be strictly comparable. Having so arranged the burners and the pressure of gas as to get the best light from each mantle, photographs of the spectra were taken, and in order to fix the wave lengths of any particular part, a spark spectrum of a standard alloy, the lines of which had been carefully measured, was impressed on the plate immediately after the artificial spectrum was photographed. Working in this way it was found that the extent of invisible radiation in which the Welsbach mantle exceeds the Sunlight mantle is largely comprised between the wave lengths 3,450 and 3,850, the total ultra-violet spectrum of the light of the Welsbach mantle being comprised between wave lengths 3,450 and 4,000, whereas that of the Sunlight mantle is comprised between wave lengths 3,850 and 4,000.

Arguing from these experiments Professor Crookes points out that "It is considered by authorities that light more than normally rich in violet and ultra-violet rays is injurious to the eyes. They contribute in time to a partial destruction of the fibres of the crystalline lens, and when excessive they produce erythema and symptoms resembling those of sunstroke. Workmen in electric light works, if frequently exposed to powerful arc lights, are affected in this way. It is not, however, desirable that the light should be too rich in yellow rays, as these temporarily destroy the erythropsine—the photosensitive substance of the retina—producing great fatigue of the nerve, and requiring darkness for its reformation and restoration of normal vision. This destruction and reformation is a natural accompaniment of the ordinary exercise of sight, but as the yellow rays are most active it is advisable that they should not be in excess. For these reasons the best form of artificial light is one containing little or no ultra-violet rays, no excess of yellow rays and just sufficient red light to communicate a warm pleasant tone to the surrounding objects," and he comes to the conclusion that "The injurious effects of artificial lights on the eye being principally attributable to the invisible ultra-violet radiation, the Welsbach light may be considered to be 2·5 times as harmful as the Sunlight mantle light."

It is manifest, however, that in ordinary practice the glass of the chimney and globe will cut off most of the noxious rays, whilst daylight is far more actinic than the light emitted by the mantle.

In order to as far as possible counteract the injury and discomfort caused to the eye by such intense centres of illumination, it becomes necessary to use globes to obtain a better distribution of the light and at the same time a protection to the eye, but in gaining this advantage a considerable sacrifice is generally made in light. For ordinary purposes ground-glass, opal or frosted globes are used, whilst in many houses these globes are made in pink-tinted glass to as far as possible neutralise the ghastly effect which the Welsbach light gives to the complexion. With all such globes the loss of illumination is considerable and the diffusion of the light far from satisfactory, but this year has seen the introduction of a diffusion globe based on an entirely different principle, and which with our present tendency towards small centres of high intensity becomes simply invaluable.

These globes designed by Psarondatri and Blondel, and lately introduced under the name of Holophane globes, give us the power not only of correcting the irregular distribution of light from the mantle and bringing the maxima of rays down to the working angles, but also make the surface of the globe the light-distributing medium.

In order to do this the globe is made of clear glass, so moulded that the exterior consists of horizontal lines of prismatic form running round the globe, whilst the interior is covered by vertical lines of prisms running from the top to the bottom.

If the globe only had the horizontal prisms around it, the source of light in the centre of the globe would appear as a vertical band of light as is seen in the Fredureau globe, whilst if the vertical prisms only were present, the light would be drawn into a horizontal band in the same plane as the mantle, but the combination of the two draws the light evenly over the whole surface of the globe.

The horizontal prisms are so moulded as to deflect downwards the excess of light otherwise escaping upwards; this gives an increase in illuminating power over the working angles, whilst the large surface of emission makes the light pleasant instead of irritating to the eye.

In order to ascertain how these globes compared with those most generally used with Welsbach burners, I made a long series of tests on the radial photometer as to the absolute gain or loss in direct illumination afforded by their use.

In making these experiments five observations were taken with the unshaded mantle, then ten with the shade that was under trial, and immediately after five more with the unshaded burner, so that for each globe a separate set of ten observations with the unshaded as well as the shaded light were obtained, and the per-centage loss or gain calculated from the average results. Observations having in this way been made for the angles below the horizontal, the results indicate the absolute gain or loss due to the shade or globe at that angle. It would be unnecessary and indeed confusing to give the enormous mass of figures obtained in this way, and the following Table gives a summary of the mean loss or gain in light due to the globes used at angles between the horizontal and 45 degrees below it:—

PER-CENTAGE GAIN OR LOSS OF LIGHT DUE TO USING VARIOUS GLOBES WITH A WELSBACH MANTLE.

Globe.		Per-centage gain or loss in light.	
Holophane—Tulip shape..	gain of	12·3	per cent.
Holophane—Conical......	,,	13·1	,,
Holophane—Conical pink	,,	1·1	,,
White opal globe	loss of	7·5	,,
Ground-glass globe	,,	12·4	,,
Frosted glass—Tulip......	,,	11·2	,,
Frosted glass—Pink	,,	23·2	,,
Pink opal globe..........	,,	34·1	,,

These results not only show the great gain which is obtained by the use of the Holophane globes, but also bring out in the clearest possible way the serious loss of light involved by the use of pink-tinted globes and shades.

It must not be supposed for one moment that these figures impute a power of creating light to the Holophane globes. If the light emitted in every direction was to be taken, a small total loss would be found due to the absorption of some light by the glass, but the angles at which the upper prisms are set deflect downwards some of the rays which otherwise would be expended on the cornices.

The more uniform distribution of light taking place from a far larger surface than the original source does away with sharp shadows and the flaring contrast between the source of high intensity and the objects illuminated by it.

Interesting experiments have been made by several observers which seem to show that if the diffused light thrown by opal and ground-glass shades be measured as well as the direct illumination, the loss of light due to them is not as great as used to be supposed, and Stott deduces from his experiments the fact that clear glass globes cut off 6 per cent. of total light, whilst flash coated globes are responsible for a loss of 11 per cent., figures which agree very well with those I have put forward; in other words, in order to gain any true idea of illuminating effect you must take the light emitted over all the working angles and not on the horizontal plane.

The illumination of outdoor spaces and roadways calls very different treatment to the lighting of the interior of our houses. In this form of lighting there is no reflection from the ceiling to help the feebleness of the downward radiation, and reflectors become almost a necessity. It is in outdoor illumination that the Welsbach incandescent mantles find their true application, and anyone who has seen the magnificent effect produced by their grouping in the Champs Elysée, and the way in which they entirely dwarf the electric installations in their immediate neighbourhood, must feel that both in economy and effect they are the best outdoor illuminant that can be obtained, and with the standards placed at sufficiently close intervals to prevent zones of darkness between them leave little to be desired.

Even here, however, one finds circumstances under which the colour of the light emitted by the Welsbach mantle is a drawback.

Observation shows us that as long as the atmosphere is sufficiently clear to enable us to see the sun or moon apparently white, but little difference can be noticed in the penetrating power of our outdoor illuminants, but as soon as the sun or moon begins to show a yellow or reddish tint, we immediately begin to notice that the arc light or the incandescent Welsbach mantle begins to fade far more rapidly than the ordinary gas lights, and that even in the thickest fog, the gas flame, oil lamp, and even candle seem able to battle more successfully with the atmospheric conditions than their more pretentious rivals.

Although this is perfectly clear to the eye, as far as I know no attempt has been made to ascertain the ratio of the per-centage of light so absorbed amongst our ordinary illuminants themselves, although Professor Tyndall's beautiful work on lighthouse illuminants shows clearly the differences which exist in this respect between the electric light and the light due to gaseous flames.

The explanation of the yellowish-red appearance seen during a fog is that it is caused by the filtration of the light rays through the minute particles of which the fog largely consists, and the same effect is produced when the sun is seen through smoke. The colours in the spectrum are produced by variations in the wave lengths, the difference from crest to crest of the red rays being large as compared with the wave lengths which give the blue-violet end of the spectrum, and the gradual decrease in the distance between the crests is found to take place from the red rays down to the ultra-violet, and when the bundle of mixed rays which we call white light comes to penetrate the finely-divided mass of particles, the small and rapid waves of the blue and violet become checked and absorbed, whilst the waves of greater amplitude are able to find their way through the obstructions, the result being that the light which reaches our eye being bereft of a large proportion at any rate of the blue and violet rays, has a preponderance of the light from the other end of the spectrum, and therefore appears red or orange in colour according to the thickness of the obstruction through which it has passed.

A very beautiful way of showing this is to cause the horizontal rays from an electric lantern to pass through a cell containing a dilute solution of sodium hyposulphite, when a white disc is formed on the screen. On now adding some hydrochloric acid to the hyposulphite, a gradual separation of particles of sulphur takes place and forms a cloud in the liquid, and this behaving in the same way as the solid particles suspended in the fog, the disc of white light is seen to go through the changes of colour so familiar to Londoners during the fall of the year.

I have attempted to utilise a modification of this experiment in order to determine the power of penetrating fog which our illuminants possess, and to do so constructed a glass cell 18 inches deep by 18 inches wide, by 3 inches thick. It was filled with a solution containing 0·1,075 grammes of sodium hyposulphite to the litre. The illuminating power of the light source to be tested was first read on the photometer in the ordinary way, and the cell containing the clear liquid was then interposed halfway between the source of light and the screen, and a second reading was taken, the difference between the two giving the light cut off by the cell and the liquid which it contained. ·05 grammes of hydrochloric acid per litre was then added to the liquid, and the solution was allowed to stand until the fine haze of sulphur particles which separated from the hyposulphite had finished forming, experiments showing that this took some time, but that owing to the extremely fine state of division of the particles the haze would remain constant when once formed over a very long period. When the haze had completely formed another reading was taken, and from the three figures so obtained it was possible to deduce the amount of light absorption due to the haze in the liquid as apart from the absorption of the cell and the liquid which it contained.

Working in this way, with the greatest possible care, it was found that considerably less light was absorbed from the yellow coal-gas flame than from the whiter acetylene flame, whilst the absorption of the greenish-blue light of the Welsbach mantle was very great indeed, as is shown by the following Table:—

Per-centage Loss of Light from various Illuminants in passing through Artificial Fog Solution.

Coal-gas flames	11·1
Acetylene flames	14·7
Welsbach mantle	20·8

which means the acetylene suffers to the extent of 32 per cent., and the Welsbach burner loses 87·3 per cent. more of its light-giving power than our old friend the gas flame.

In all methods for obtaining light, the great test for the efficiency of the process is after all the per-centage of the energy employed which is transformed into light, and we find that the amount so utilised is extremely small in all our artificial illuminants.

Per-centage of Energy Transformed into

	Heat.	Light.
Candles	98	2
Oil lamps	98	2
Coal-gas—		
Flat flame and Argand	98	2
Regenerative	93	6
Incandescent	88	12
Electric light—		
Geissler tubes	97	3
Arc	90	10
Incandescent	95	5
Magnesium light	85	15
Sunlight	70	30
Glow worms, fire flies, and luminous beetles	1	99

It is evident, therefore, that great as has been the advance made by the incandescent mantle over all other methods of consuming coal gas, there is still an immense field open for further improvements, and our present incandescent mantles might easily be surpassed in their power of emissivity.

Notes on Books.

Practical Electricity. By W. E. Ayrton, F.R.S. Volume I.: Current, Pressure, Resistance, Energy, Power, and Cells. London: Cassell and Co.

Professor Ayrton describes his book as a Laboratory and Lecture Course for First Year Students of Electrical Engineering, based on the International Definitions of the Electrical Units. It is founded on the book of the same name, published in 1886, but has been re-written, enlarged and modified, to bring it up to a level with the very altered conditions of electrotechnics existing now, as compared with that of ten years back.

In the older text-books electricity was treated mainly as a pure science, a science of research. The subject was treated in the same order as had been followed in its actual developments, from the observation of the effects produced by friction on amber, glass, and sealing-wax, through frictional machines, and so on to galvanic electricity, the telegraph, and the dynamo. For the practical student the order required to be reversed. Having become familiar with the ordinary phenomena of current in connection perhaps with telegraphic or electric-lighting work, he demands that these phenomena should be taken as a starting point for the theoretical instruction he requires to supplement his practical experience, and rejected teaching the bearing of which on his regular daily avocation it seems hard to trace.

Professor Arylon realised this fact, and in the first issue of the work under review he adopted a scheme more consonant with the actual requirements of his students. He, therefore, started with the electric current, for the reason that in all industrial applications of electricity it is the current which is employed, and also because currents can be compared and measured without any knowledge of potential difference or resistance. In his earlier editions he dealt next with potential, and left resistance to the last. Having regard, however, to the fact that the Board of Trade unit, the volt, depends on the ohm, the unit of resistance, the arrangement in the present volume has been modified, and the actual sequence is "(1) current and the ampere; (2) the relative measurement of P.D.'s with a zero electro-static voltmeter; (3) Ohm's law; (4) resistance, and the ohm; (5) the volt and current voltmeters." Electric energy and power, with their units—the joule and the watt—are next treated; and lastly, the conception of the E.M.F. in a circuit, and the necessity for the E.M.F. of a good cell being constant, are derived from the laws of energy.

Beautiful Sydney (1895-96), including Newcastle Coalopolis and Fertile Maitland. Sydney: G. Robertson and Co.

This volume contains a series of views of the chief public buildings of Sydney, and of some of the most beautiful scenes in and about the city, and around the matchless harbour, as well as representations of private residences and houses of business. Newcastle is described as the coal centre of the Southern Hemisphere, and Maitland, besides possessing a rich soil, is said to possess one of the thickest and extensive coal seams in the world.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

January 20.—"The Roller Boat of Mons. Bazin." By Emile Gautier.

January 27.—"Voice Production." By William Nicholl.

February 3.—"Development of Ireland's Industrial Resources." By the Hon. Horace Plunkett, M.P. (Chairman of the Recess Committee).

February 10.—

February 17.—"Light Railways." By Everard R. Calthrop. The Attorney-General, G.C.M.G, M.P., will preside.

Papers for evenings, the dates of which cannot yet be announced:—

"The Prevention of Fires due to the Leakage of Electricity." By Frederick Bathurst.

"English Orchards."—By George Gordon.

"Dairy Produce and Milk Supply." By M. J. Dunstan, M.A., F.R.S.E.

"The Transmission of Power by Alternating Electric Currents." By W. B. Esson, M.Inst.C.E.

"London Water Supply." By Percy F. Frankland, Ph.D., F.R.S.

"The Chemistry of Tea." By David Crole.

"The Evolution of the Silver Question." By Moreton Frewen.

"Children's Sight." By R. Brudenell Carter, F.R.C.S.

"Cycling—Historical and Practical." By George Lacy Hillier.

Indian Section.

The meetings of this Section will take place on the following Thursdays, at Half-past Four and Eight o'clock:—

January 28, at 4.30 p.m. — "The Moral Advance of the Peoples of India during the

Reign of Queen Victoria." By William Lee-Warner, M.A., C.S.I., formerly British Resident in Mysore, and Chief Commissioner of Coorg. The Right Hon. the Lord Herschell, G.C.B., D.C.L., will preside.

February 11, at 4.30 p.m. "The Progress of Science Teaching in India." By Professor Jagadis Chundra Bose (of Calcutta), D.Sc.

March 11, at 4.30 p.m.—"Prevention of Famine in India." By Sir Charles Alfred Elliott, K.C.S.I. (Secretary to the Famine Commission of 1878, and late Lieutenant-Governor of Bengal). The Right Hon. Lord George Hamilton, M.P., Secretary of State for India, will preside.

March 25, at 8 p.m.—"The Cultivation and Manufacture of Rhea Fibre." By Thomas Barraclough.

April 8, at 4.30 p.m.—"A Visit to Russian Central Asia." By Michael Francis O'Dwyer, I.C.S. (Assistant Commissioner in the Punjab).

April 29, at 4.30 p.m.—"The Ethnology, Manners, and Customs of the People of Kafiristan." By Sir George Scott Robertson, K.C.S.I. (late British Agent at Chitral).

May 20, at 4.30 p.m.—"India and its Commerce." By Sir James Lyle Mackay, K.C.I.E. (late President of the Bengal Chamber of Commerce).

The meetings of March 11, April 8, April 29, and May 20 will be held at the Society of Arts; and those of January 28, February 11, and March 25 at the Imperial Institute.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesdays, at Half-past Four o'clock:—

February 2.—"The Progress of the British Colonial Empire during the past Sixty Years of Her Majesty's Reign." By the Rt. Hon. Sir Charles W. Dilke, Bart., M.P. The Earl of Jersey, G.C.M.G., in the chair.

February 16.—"The Progress of Canada during the past Sixty Years of Her Majesty's Reign." By Joseph G. Colmer, C.M.G. The Marquis of Lorne, K.T., in the chair.

Applied Art Section.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 26.—"The Artistic Treatment of Heraldry." By W. H. St. John Hope, M.A.

February 9.—"Lithography as a Mode of Artistic Expression." By George McCulloch.

March 2.—"Gesso." By Matthew Webb.

March 30.—"Lead-work." By W. R. Lethaby.

April 27.—"Delft Ware." By Dr. J. W. L. Glaisher, F.R.S.

May 11.—"A Half Century of Line Engraving, 1780-1830." By George Clulow.

Cantor Lectures.

Monday Evenings, at Eight o'clock:—

William Burton, F.C.S., "Material and Design in Pottery." Four Lectures.
January 18, 25, February 1, 8.

C. F. Cross, F.C.S., "The Industrial Uses of Cellulose." Three Lectures.
February 15, 22, March 1.

Prof. W. Chandler Roberts-Austen, C.B., F.R.S., "Alloys." Four Lectures.
March 15, 22, 29, April 5.

Lewis Foreman Day, "Design in Lettering." Four Lectures.
May 3, 10, 17, 24.

Howard Lectures.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Thursday Evenings, at Eight o'clock:—

Prof. James A. Ewing, M.A., F.R.S., "The Mechanical Production of Cold." Six Lectures.
January 28, February 4, 11, 18, 25, March 4.

MEETINGS FOR THE ENSUING WEEK.

Monday, Jan. 4...Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. Arthur Caldecott, "The Smelting and Refining of Cyanide Bullion." 2. Professor Roberts-Austen, "The Industrial Use of a Recording Pyrometer."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Captain A. S. Gibbons, Mr. Percy C. Reid, and Captain A. Bertrand, "An Expedition to the Barotse Country."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Dr. Walker, "The Botany of Egypt."

London Institution, Finsbury-circus, E.C., 4 p.m. Professor J. A. Fleming, "Rays of Light: New and Old." (Juvenile Lecture III.)

Tuesday, Jan. 5...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lectures.) Professor Silvanus Thompson, "Light: Visible and Invisible." (Lecture IV.)

Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.

Self-Propelled Traffic Association, Royal Institution, Liverpool, 8 p.m. Mr. G F. Thompson, "The Motor Waggon scientifically considered."

Wednesday, Jan. 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 7 p.m. (Juvenile Lectures.) Mr. C. T. Dent, "The Growth and Demolition of Mountains." (Lecture I.)

Thursday, Jan. 7...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lectures.) Professor Silvanus Thompson, "Light: Visible and Invisible." (Lecture V.)

Saturday, Jan. 9...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lectures.) Professor Silvanus Thompson, "Light: Visible and Invisible." (Lecture VI.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

On Wednesday evening, 6th inst., Mr. Clinton T. Dent, F.R.C.S., Past President of the Alpine Club, delivered the first lecture of his course, addressed to a juvenile audience, on "The Growth and Demolition of Mountains." After referring to the indestructibility of matter, he illustrated the various changes in nature, which form a complete circle, by a heated kettle of water; the boiling water issues from the kettle as steam, and being condensed on a cold plate of glass, becomes water again. A further example was shown in a lantern slide of the Weisshorn, in which, half-way up the mountain, was seen a cloud; this turned into rain or snow, according to its altitude, and, in the latter case, when melted, helped to form a river, which ultimately flowed into the sea. From the sea the water was drawn up by evaporation to form fresh clouds and rain, thus again completing the circle.

The bending up of geological strata was illustrated by layers of coloured woollen stuff, and when pressure was applied to these, the layers exhibited wrinkles and folds. Examples of similar wrinkles and folds were shown in the photograph of mountains in the Caucasus. The chief agencies in the wearing away of mountains were water, heat and cold, and chemical action. The action of water was shown by means of a wooden slide on which were placed sand and salt; the water being poured over this, dissolved the salt and washed away the sand, at the same time partly soaking into the board. So in nature salts were washed out, insoluble matter swept away, and the rock percolated by water. The expansive force of ice was also demonstrated. The action of water charged with carbonic acid gas in dissolving out lime from limestone and depositing it afresh was shown by experiment.* From the lime carried away in water, mountains grew at the bottom of the sea, thus the mountains of Switzerland were originally formed in the great inland sea which once existed in the centre of Europe. Lime was also taken up by living organisms, and a calculation had been made that the Rhine took down to the sea a sufficient amount of lime to form many million oyster shells. The lime taken down to the sea was stored there ready for re-formation. Thus the circle of changes was again illustrated.

The lecturer dealt in this lecture with the formation and demolition of mountains by slow processes. In the second lecture, to be delivered on Wednesday evening next, 13th inst., he will treat of the more rapid processes of destruction by avalanches, glaciers, &c.

Proceedings of the Society.

CANTOR LECTURES.

THE USE OF GAS FOR DOMESTIC LIGHTING.

By Professor Vivian B. Lewes,

Chief Gas Examiner to the Corporation of the City of London, &c.

Lecture III.—Delivered December 7, 1896.

Although coal gas is by far the best illuminant that can be employed, there are many villages and small towns still existing where the small consumption would render a gas works commercially impossible, and where, therefore, the oil lamp and candle still reign as the chief methods of obtaining light. Under these circumstances, and also in country houses and institutions, such as workhouses, hospitals, infirmaries, &c., gas made from substances other than coal is frequently employed.

The great class of bodies which we call hydrocarbons, and which include all the waxes, fats, and oils, and many gaseous compounds, have been shown by experiment to be simplified in their composition by the action of heat. The more complex ones in which many atoms are packed away in the molecule have as a rule the solid form, such as a wax or fat. On heating, these complex bodies break up and become simplified in form, and amongst these less complex bodies the liquid hydrocarbons play an important part. These again become further simplified by the action of a higher temperature or more prolonged heating until the simplest or gaseous hydrocarbons are obtained, whilst these latter can again be broken up into their constituents, carbon and hydrogen. It is, therefore, manifest that, given a solid or liquid compound of carbon and hydrogen, these may be converted into gaseous matter with much the same characteristics as are to be found in our coal gas, and oil gas made by the breaking up of various grades of oil has been in use for as long a period as coal gas itself.

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* Specimens exhibiting the erosion of limestone rocks were kindly lent to illustrate the lecture by the Director of the Museum of Economic Geology.

Many forms of apparatus have been devised for the production of this gas, but most of them only differ from each other in the general arrangement of the apparatus and not in any specific principle. Of the oil-gas processes, those which have received the most general support have been the Pintsch, Pope, and Patterson, the chief differences between which are in the shape of the retort and the method of introducing the oil into it, and all such methods of decomposition give liquid and solid residuals as well as the oil gas.

The Patterson plant consists of a horizontal retort of cylindrical form built into a furnace, containing an oven or flue space in which the retort is placed. The oil to be converted into gas is led from the oil tank into the retort by two straight horizontal pipes extending from the front nearly to the back of the retort, the inner or back ends of these pipes being open. The supply of oil is partly converted into vapour whilst passing along these pipes, and on issuing from the ends is further decomposed by the heat in its passage from the back to the front of the retort where the outlet is situated. The main supply of oil is regulated by a stop-cock, whilst another tap on each retort pipe controls the supply to the retorts. The gas passes from the retorts into an atmospheric condenser and then into the holder. The arrangement of the apparatus allows of the action being easily and satisfactorily regulated and controlled.

The manufacture of an oil gas in any such apparatus requires care in the selection of the material to be decomposed, and the essential points which govern the selection are first, the cost of the crude material; and secondly, ease of working. A long series of experiments made by me to ascertain which is the best hydrocarbon to employ and the best temperature at which to work, gave 900° C. as the temperature at which the best results are obtained, and that the oils best adapted for use are the Russian Solar Distillate—obtained by further distillation of the residue of Russian Baku oils after the lighter kerosenes have been driven off—and nearly as good are the blue and green shale oils. Working with these oils at a temperature of 900° C. the best results obtainable per gallon would be 98 cubic feet of 50-candle gas, which would be equal to 980 candles per gallon of oil, and in each case there would be about 20 per cent. of the volume of the original oil condensed as residuals, these latter containing a certain amount of benzine as well as paraffins and olefines of low boiling points, but which were of very little use for recracking.

From time to time attempts have been made to manufacture oil gas in such a way that there shall be no liquid residues, and that the whole of the oil shall be converted into gas, or left as a solid residue in the retorts. The first process of this kind was one introduced in 1846, by Hilary, who placed tube condensers above his oil retorts, so that all the liquid condensed ran back into the retorts and became further carbonised, his ultimate products being nothing but coke and gas.

This idea has been further improved by Mr. W. Young, whose method of retorting oil in such a way as to yield nothing but coke and gas, has achieved a very great success, and plays a very important part in the methods of enriching poor coal gas now largely adopted in the North of England and Scotland, in which oil gas takes the place of cannel coal in bringing up a 15-candle coal gas to the absurd standard which public opinion there seems to think necessary.

Young's process for the manufacture of oil gas from the Scotch shale oils is entirely dependent upon the principle of washing the oil gas retorted at a moderate temperature by means of the oil which is afterwards to undergo decomposition, a process which frees it from all condensible vapours, and allows only permanent gases to escape to the purifiers. There is no doubt but that in doing this very considerable quantities of the olefines and other fixed gases are also absorbed, but as these are driven out again by the action of heat during retorting, no loss takes place.

The plant used consists of cast iron retorts about 10 feet long, set so as to incline downwards to the far end. The retorts are fitted with door and ascension pipes in the usual way, but in each door there is a small tap, on opening which the colour of the gas being made can be seen. This should be a pale lemon colour, as, if the colour approaches brown or any darker tint, deposition of tar and an inferior gas are the result. The oil to undergo decomposition is admitted through a small tap about 2 feet up the ascension pipe and falls down through the ascending gas on to steel plates, which extend 3 feet into the retort, thus preventing as far as possible the direct impact of the oil on to the bottom of the retort. The temperature employed ranges from about 800 to 900° C.

The gas as it leaves the retorts passes up the ascension pipes to the hydraulic main, and through a coil of horizontal condensing pipes into the scrubber. This latter is made in four compartments, the oil cistern being situated at the top, and the supply pipe is so arranged as to allow the oil to flow into any or all of the sections. The oil, after flowing through the scrubber, passes along the bottom of the condensers in a direction opposite to that in which the gas is passing, and into the hydraulic main. It then enters a small cistern fitted with a float and telltale by which the rate of flow is rendered visible, the indicator being close to the taps which control the supply to the retorts, and by this means it is easy to see if the oil is flowing too fast into the retorts to be properly cracked or too slowly, and accordingly the supply can be regulated to keep the balance constant. The oil used is what is technically known as "blue oil," with a specific gravity on an average of about ·850. Each retort will make 500 cubic feet of oil gas per hour, and for every ton of oil decomposed 5½ cwts. of a very hard metallic-looking coke remain in the retorts. This coke collects almost entirely at the back of the retorts and can readily be removed, whilst it forms with a perfectly horizontal surface which seems to suggest that it flowed there in the condition of pitch and was then carbonised, or else that carbon deposited in the ascension pipes has been washed down by the oil.

The gas obtained by this process when burnt *per se* in the burners most suited for its consumption, gives in the photometer an illuminating value of 50 to 60 candle-power, but the enriching value is said to be considerably above this. The reason for this phenomenon is that the duty obtainable from any burner is entirely dependent upon the regulation of the size of the flame, so that the gases as they burn shall get a proper proportion of oxygen within a reasonable distance of the nozzle of the burner, and also upon the temperature of the flame itself. From this it will be seen that a gas of a certain illuminating power will give varying results according to the burners in which it is consumed, the burner suited for a poor coal gas being utterly unfitted for a rich gas, a point which is too often overlooked, not only in the testing the illuminating value of gases but also in their practical consumption. A 16-candle gas requires a very large burner in order that we may get the best results from it as a flat flame, but the size of the burner has to be rapidly decreased as the proportion of heavy hydrocarbons in the gas increases, as sufficient air must be supplied to the flame in order that it may burn without smoking, and the smaller the flame the greater will be the cooling action of the nitrogen of the air and also of the burner, and the result is that a burner has to be selected for each gas of such a size that the gas will burn just without smoking.

If an oil gas for instance be taken, which is capable of emitting an illuminating value of 50 candles per 5 cubic feet, it will be found that the No. 2 Bray burner will give a heavy smoky flame, and this would be worse as the size of the burner increases, but if a No. 0 Bray were employed, a smokeless flame would be the result, and this burner would give an illuminating value slightly under 50 candles per 5 cubic feet of gas consumed. If the size of the burner be now decreased, the illuminating power recorded will also decrease, until with No. 000 Bray the gas would only have an illuminating power of 35 candles per 5 cubic feet, this falling off being entirely due to the cooling of the flame. Manifestly, therefore, with such a gas the No. 0 burner would be the best to employ in order to get the highest results from it. With a 60-candle gas it is impossible to get a burner which will develop the maximum illuminating power of the gas, as the cooling action destroys a large per-centage of the value of the gas, the burner having to be so small in order to yield a flame which shall not smoke. From this reason it often happens that the enriching value of an oil gas is higher than would be expected from the results obtained when the gas is burnt by itself in the photometer.

The differences which exist in chemical composition between oil gas made by the various processes is, after all, but slight; the Young process, however, owing to the slightly lower temperature which is employed, gives a gas which is richer in unsaturated hydrocarbons—*i.e.*, hydrocarbons which have the greatest power of illumination during combustion, and which consist chiefly of ethylene and butylene, the average of many analyses of gases being comprised in the following Table:—

TABLE I.—COMPOSITION OF OIL GAS.

	Young.	Patterson.	Pintsch.
Unsaturated hydrocarbons	43·83	33·16	35·65
Saturated hydrocarbons	36·30	45·15	45·37
Hydrogen	16·85	19·65	12·44
Carbon dioxide	0·63	0·50	0·74
Carbon monoxide	0·00	0·50	0·60
Oxygen	1·14	0·60	2·00
Nitrogen	1·25	0·44	3·20
	100·00	100·00	100·00

For domestic illumination oil gas has many drawbacks, as in the first place the apparatus which has to be employed for its manufacture is almost as bulky as a small coal gas installation. It necessitates scrubbers of much the same character, whilst keeping the furnace heats constant for raising the temperature of the retorts requires most careful attention, as otherwise stopped ascension pipes and burnt retorts constitute a very serious cause of delay and expense, whilst in the consumption of the gas the burners employed have to be so small as to seriously detract from the illuminating value of the gas. Its tendency to smoke when any considerable variation in the richness in hydrocarbons takes place is anything but a satisfactory quality for the country householder.

At the present time the introduction of acetylene gas, made by acting upon calcic carbide with water, and which is at once the most easily made and the most brilliant of all known gases, promises a complete revolution in domestic lighting where coal gas is not to be obtained, but much has yet to be done in educating the public as to the proper way in which to use it, as well as in the character of the calcic carbide from which it is produced, and in the forms of apparatus employed to generate the gas.

Acetylene, or as it is sometimes scientifically called, ethine, is a gaseous compound of 24 parts by weight of carbon with 2 of hydrogen, and was first discovered and isolated by Edmund Davy in 1836, but it was not until 1859 that Berthelot's investigations gave the scientific world a clear conception of its interesting character and properties. Since that time it has been frequently prepared in small quantities by tedious and costly processes, and it is only within the last few years that a cheap and simple method has been discovered and has brought its use within the range of commercial possibility.

The fact that carbon and lime could be made to directly act upon each to form calcic carbide was discovered independently by Willson in America, and in France by M. Moissan, but there exists abundant proof that Willson was making and experimenting with calcic carbide, and had sent specimens of it to various correspondents some time before Moissan had made any announcement of his discovery, and therefore priority undoubtedly rests with the American discoverer.

Calcic carbide is a dark grey substance having a specific gravity of 2·262, and when pure a pound of it will yield, on decomposition, 5·8 cubic feet of acetylene. Unless, however, it is quite fresh, or means have been taken to carefully protect it from air, the outer surface becomes slightly acted upon by atmospheric moisture, so that in practice the yield would not much exceed 5 cubic feet. The density and hardness of the mass, however, protect it to a great extent from atmospheric action, so that in lumps it does not deteriorate as fast as would be expected, but in the powdered condition it is quickly decomposed.

On the addition of water to the calcic carbide a double decomposition takes place, the oxygen of the water combining with the calcium and once again forming lime, whilst the hydrogen unites with the carbon of the carbide to form acetylene.

At the present moment the future of acetylene as an illuminant is largely dependent upon two factors, the commercial production of calcic carbide of a reasonable degree of purity, and secondly methods for safely making and burning the gas in such a way as to develop its full illuminating power whilst doing away with the risk of smoking; and as I first drew attention to the production of the carbide, and from it of the acetylene on a commercial scale in this country, I feel that the results of the past two years' experience will not be without interest.

In spite of extended experience both here and abroad in the manufacture of calcic carbide, the details given as to its cost and the price at which it can be purchased offer the most entertaining reading, as whilst the patentee and would-be seller of acetylene generating plant still talk airily of the cost of the carbide being anything from 30s. to £7 a ton, the price at which one can purchase carbide more nearly approaches £30. Indeed, in Paris at the present moment there is considerable difficulty in getting it at £40 a ton, although we are informed that this is merely due to a temporary carbide famine, and that the new sources of supply will soon reduce the selling price even below £16 a ton, at which it stood before the late rise in price. Be this as it may, the factor which interests us is the price at which carbide can be obtained in England, and the Acetylene Illuminating Company, who hold the Willson patents for the production of carbide, and also the Cowles electric furnace patents, which I believe enable them to control the manufacture of carbide in this country, have fixed their selling price at £28 per ton, and although there is no doubt that they will give contracts in considerable quantities at a reduction on this price, yet it is with the factor of the selling price to the public and not with the manufacturing price that we have to deal.

In most cases, the possible prices quoted for calcic carbide by inventors who have been carried away by their wishes rather than by hard facts, are simply absurd, and far below the price at which the substance can be produced, and it may be of interest if I give the figures for the electric power necessary, which I myself have obtained in practice in the manufacture of calcic carbide.

Having been kindly granted the use of the electric plant erected for the manufacture of calcic carbide at the experimental works of the Acetylene Illuminating Company, a plant capable of working continuously at from 60 to 70 volts at 1,000 to 1,200 amperes, I made a series of experiments in order to determine the best proportions in which to mix the ingredients from which the carbide is manufactured, and to find out the amount made per electric horse-power.

The production of carbide from lime and carbon under the influence of the heat of the electric furnace appears to take place according to the formula—

$$CaO + C_3 = CaC_2 + CO,$$

and in order to obtain this reaction it would be necessary to use 56·1 per cent. of lime mixed with 43·9 per cent. of carbon. In practice, however, it must be remembered that the carbon used will either be finely-powdered coke or charcoal, neither of which are pure carbon, whilst the lime employed will always vary in purity, such variations having, as I shall presently show, a very important bearing upon the purity of the carbide and acetylene produced from it. Another practical point also presents itself, and that is that unless the mixture is suitably arranged, considerable variations in the amperage and consequent loss of efficiency in the furnace will result.

Using a mixture of 60 per cent. of lime and 40 of carbon, a run lasting 3½ hours yields about 112 lbs. of fused ingot, and of this 81 per cent. was practically pure carbide, the remainder being a crust of lower value.

The mixed carbides yielded 5 cubic feet of gas per pound, and contained 89·2 per cent. of true carbide, hence the yield may be taken as being 32 lbs. per hour of the commercial carbide.

The current used was 60 volts at 1,000 amperes or 89 E.H.F., which gives as the make about 0·4 lbs. per E.H.P. per hour, and the result of continued experiments show that 0·3 to 0·4 lbs. per E.H.P. per hour is the average yield.

The cost of the electrical horse-power will, of course, vary with the source from which it is obtained, and the use of steam power for generating the electricity appears too costly to be entertained, unless the present electrical lighting stations could see that it was to their advantage to level up their load by manufacturing the carbide under license when not employed in supplying current directly for illuminating purposes. The Acetylene Company have, however, secured considerable water-power at the Falls of Foyers, and a full installation of carbide plant is at work there, whilst still further water-power has been secured in a convenient position, and additional works will be erected; but it will always be the demand and not the cost of the carbide which will govern the price.

The following yields of acetylene from various samples of commercial carbide that I have analysed give an idea of the variations to be found in the article :—

Swiss carbide per lb.—I. yielded 4·38 cubic feet of acetylene; II. yielded 4·60 feet; and III. yielded 4·56 feet.

German carbide per lb.—I. yielded 3·82 cubic feet of acetylene; II. yielded 3·46 feet; III. yielded 3·24 feet; IV. yielded 2·43 feet.

English carbide per lb.—I. yielded 5·24 cubic feet of acetylene; II. yielded 4·84 feet; III. yielded 5·04; IV. yielded 5·52 feet; V. yielded 4·84 feet; VI. yielded 5·32 feet.

It is evident, therefore, that there are wide differences in the commercial article, but with reasonable care in the manufacture, the carbide should yield an average of 5 cubic feet of acetylene per pound.

The gas obtained from the English carbide is very pure, the chief impurity being 2-3 per cent. of sulphuretted hydrogen, due to sulphur in the coke and gypsum in the lime, whilst with many of the Continental samples 6-9 per cent. of impurities is by no means uncommon, one of the principal and most dangerous impurities being phosphuretted hydrogen, which is evidently due to the use of phosphatic lime in the manufacture of the carbide, and also traces of siliciuretted hydrogen. So bad is this with some samples that the acetylene produced from one batch obtained from Denmark actually gave a haze when burnt for some time in a small room.

It is manifest that if the carbide is contaminated with calcic phosphide, the action of the water on it must give rise to a certain quantity of spontaneously inflammable liquid phosphuretted hydrogen as well as the gaseous compound, and the liquid condensing during compression or in the storage holder is a very grave source of danger. No lime or coke should be used in the manufacture of carbide which contains more than the smallest trace of phosphates, and if this point is not more carefully attended to than it is at present in some of the Continental works, serious accidents are sure to follow, whilst if this be done as is the case in the manufacture of English carbide, no danger from this cause need be apprehended.

Ammonia is also found as a frequent impurity in acetylene, and gives it the power of attacking copper with the formation of an explosive compound.

In the paper which I read before the Society of Arts in January, 1895, on acetylene, I pointed out the ease with which the acetylene was liberated from the carbide by the action of water, and suggested several forms of apparatus in which such decompositions might be brought about. These suggestions were followed by a rush of would-be inventors upon the Patent-office, the literature of which has been increased to an alarming extent during the past two years by patents, many of which are characterised neither by novelty or utility, and which moreover are in cases fraught with considerable danger. With the further experience which I have gained in the production and properties of this gas, I now see that many of the hints which I threw out in that paper as to the construction of apparatus would be fraught with many drawbacks, as although most of the dangers with which acetylene was then credited have disappeared into thin air, some other totally unexpected ones have taken their place, and most manufacturers of acetylene apparatus being still ignorant of these, a lively time may be expected for those who employ apparatus constructed by people who, possessing a limited mechanical knowledge, know absolutely nothing of the properties of the gas with which they are dealing, and these are certain to give rise to many troubles in use, and so retard the utilisation of this beautiful illuminant.

In the generation of acetylene from calcic carbide, far too little attention is being paid to the high temperature evolved when any considerable quantity of it is brought into contact with water, and the effect which this has upon the gas. Several attempts are being made to introduce automatic machines for the generation of acetylene on the principle of the ordinary "Kipp's" sulphuretted hydrogen apparatus, indeed several of them are only modified copies of this in metal, and the idea of the manufacturers is evidently that the action will cease and the evolution of acetylene be stopped when the pressure of the gas drives the water back from the carbide, but this is not so, as the heat of the action saturates the gas present with water vapour, and as the apparatus cools, this recondenses on the carbide and produces more gas, whilst the unchanged carbide will decompose the vapour before condensation, and even dehydrate the calcic hydrate which was formed on its surface when the water was in contact with it. The result of this is that after the gas has once been made, no automatic arrangement will stop the slow generation of the gas from the carbide in the apparatus.

When the gas is being continually used this does not matter much, as the slowing down of the evolution of the gas is sufficient to allow the consumption to catch up the make; but when the gas is turned off, if any quantity of carbide be undecomposed, the automatic generator with its small holder becomes an active danger, as it will either "blow" or generate dangerously high pressures.

In any form of generator where the quantity of carbide is large, the heat generated by the action of the water on the material is quite sufficient to polymerise some of the acetylene into tar-like products which will sometimes cause trouble and stoppages in the pipes, whilst in any case the high temperatures cause a large amount of steam to go forward with the gas, and unless special precautions are adopted to prevent it, such as using a sufficiently large holder, some of this is carried forward to the service pipes.

There is no doubt that for the use of the gas in country houses, a holder large enough for the evening's supply should be provided, and the generators not charged with more carbide than is necessary to yield a volume of gas equal to the capacity of the holder.

The dangers of acetylene, of which a good deal has been heard lately, are almost entirely dependent upon the use of impure carbide and improper apparatus. Pure acetylene has now been shown to be less poisonous than ordinary coal gas, and far less so than coal gas enriched with carburetted water gas, whilst the action of the pure dry gas on metals is practically nil.

It is well known that acetylene can be resolved into its constituents by detonation, and the idea has arisen from this fact that acetylene is itself an explosive of great power. This is, however, an error, as it has been clearly shown that when the gas is under ordinary atmospheric pressure, if detonation is started in acetylene by a charge of mercuric fulminate, the explosion only extends a few inches from the detonator, whilst the explosion in acetylene of acetylide of copper is insufficient to set up detonation of the gas under these conditions.

This, however, only applies to acetylene under ordinary pressure, and any attempts to liquify acetylene by the pressure created by the evolution of the gas from calcic carbide is an extremely dangerous operation, as, if the heat of generation be added to the heat evolved during compression, an action akin to detonation is very likely to take place with the resolution of the acetylene into carbon and hydrogen.

Out of the many forms of generator which have been patented in this country and abroad, there are some which, although there is no very startling novelty in construction, yet afford safety in use, and intending users of acetylene apparatus should make sure that the generators they employ have been examined and certified as safe by some competent authority.

I have pointed out some of the troubles existing in the generation of acetylene on a commercial scale, but given a good form of generator, the trouble which still exists is that there are but few burners at present manufactured which can be relied upon to consume it in such a way as to develop from it its wonderful illuminating power for any great length of time without smoking, and when the burner itself starts smoking, it can easily be realised that its capabilities in that way are immense.

For domestic illumination a burner consuming more than 1 cubic foot of the gas per hour would have too intense a light to be practically usable, and I have found it possible to make a burner which, for this consumption, shall emit a light of from 32 to 34 candles, which is ahead of the duty obtained for the same consumption by any other burners which I have tested; but with all burners, good and bad alike, after a certain period of perfect burning, which may extend to several hundred hours, a time is sure to arrive when the burner commences to smoke, and, as a rule, all that can be done with it is to take it out and put in a fresh one. The cause of this is that in all burners fitted for the consumption of acetylene the holes or slits through which the gas issues have to be excessively fine, and in time the heat of the burner causes the polymerisation of some of the acetylene into liquid hydrocarbons, which, being decomposed in the hole or slit, give rise to a slight carbonaceous deposit and the growth of carbon filaments from the outlet. The carbon filaments can easily be removed when they make their appearance, but the partial stoppage in the fine aperture of the burner itself upsets the balance of the burner and causes smoking.

The fact that burners can be obtained cheaply which for a limited time give satisfactory results, enables dealers to sell burners and to declare that no such trouble exists, but the public who are induced to buy will soon discover the facts for themselves.

Acetylene is soluble in water and many other liquids. At ordinary temperature and pressure 10 volumes of water will absorb 11 volumes of the gas, but unless the gas be bubbled through the water the absorption is hardly noticeable in the case of an ordinary receiver or gas-holder, as the surface of the water rapidly becomes saturated, and after that the absorption is very slow, whilst when the whole bulk of water is completely saturated the absorption stops.

The solubility of the gas may also be largely done away with by dissolving salt in the water surrounding the gas-holder, but this has a destructive action upon the metal of the holder, and it is therefore better to use ordinary water as the liquid over which the gas is collected and stored.

The gas can be condensed to a liquid under a pressure of 21·53 atmospheres, or 323 lbs. at a temperature of 0° C., whilst at ordinary temperatures the pressure necessary to keep it in the liquid state is from 500 to 600 lbs. on the square inch, so that the liquefied gas can readily be stored and transported in steel cylinders of the kind employed for liquid carbon dioxide.

The liquid so produced is mobile and highly refractory, and when sprayed into air, the conversion of the liquid into the gaseous condition absorbs so much heat that some of the escaping liquid is converted into a snow-like solid, which takes fire on applying a light to it, and burns until the solid is all converted into gas and consumed.

The possibility of liquefying acetylene at pressures about those at which liquid carbon dioxide is produced so largely enables considerable volumes of gas to be compressed into the liquid state in small wrought-iron or steel cylinders, and in this condition by means of suitable reducing valves and burners of the right construction it may be stored and burnt. The small cylinders can also be arranged in the form of portable lamps, whilst for use in the country where no gas is available, a large cylinder of the liquid gas placed in an outhouse would supply a country house with light for a very long period.

It is now well recognised that all luminous hydrocarbon flames owe their light-giving properties to fine particles of carbon liberated within the flame by various processes of decomposition, and raised to incandescence partly by the heat of the flame, and partly by the heat generated by the same actions which caused the separation of the carbon, and it is to the formation of small traces of acetylene in all hydrocarbon flames that a large amount of their luminosity is due. We should, therefore, expect that acetylene when burnt by itself would be the most brilliant of all gaseous illuminants, an expectation which is fully borne out by the results in practice.

Acetylene gas when burnt gives a flame of intense brilliancy, and owing to its richness it can only be consumed in small burners. Under these conditions it emits a light greater than that given by any other known gas, its illuminating value when properly developed, calculated to a consumption of 5 cubic feet an hour—the average consumption of ordinary coal gas—being no less than 240 candles. It is thus seen that when acetylene is burnt in suitable burners it develops an illuminating value fifteen to twenty times greater than that obtained by the combustion of the same volume of coal gas, so that for all practical illuminating purposes a very small consumption of acetylene in the burners, which practice has shown to be best suited for the purposes, does the illuminating work of a very large volume of coal gas, with the result that the air of the room is but little contaminated with the products of combustion, and the excessive heating of the upper portions of the air is reduced to a minimum.

The following Table contrasts the products of combustion evolved from London coal gas when consumed in various forms of burners, and giving an illumination of 48 candles, which may be presumed to be the amount of light required in a fair-sized London dining-room, and contrasted with this is the amount of the products of combustion which acetylene would evolve in giving the same amount of light, whilst to make the meaning clearer, I have added the number of adults who would exhale the same amount of carbon dioxide in the same time :—

Burner.	Gas consumed.	Carbon dioxide.	Adults.
Flat flame, No. 6	19·2	10·1	16·8
,, ,, 5	22·9	12·1	20·0
,, ,, 4	25·3	13·4	22·3
London Argand......	15·0	7·9	13·1
Acetylene	1·25	2·50	4·5

If we obtained the same amount of light from paraffin lamps, the carbon dioxide evolved would be equivalent to 22·5 adults; whilst as far as carbon dioxide goes, you might as well invite 32·7 more guests to dinner as use 48 sperm candles to supply the needed illumination.

It has been said that the danger of an explosion from a leakage of acetylene is far greater than with coal gas. This is, I think, a mistake. Mixtures of air and acetylene are explosive over a slightly wider range than is the case with mixtures of coal gas and air; but it must be remembered that if a leakage were caused by a tap being left on, the largest acetylene burner would probably only pass 1 cubic foot of gas per hour, whilst an ordinary No. 4 or 5 union jet burner would pass

5 to 6 cubic feet of coal gas in the same period of time, and from this cause, therefore, would be far more dangerous than acetylene; whilst if the leak were from a small crack or a leaky joint in a pipe, the rate at which the gases diffuse out would be dependent upon their specific gravity. Coal gas has a specific gravity of 0·4 as against 0·9 for acetylene; so that through a crack or fissure of the same size, only two volumes of acetylene would escape, whilst three volumes of coal gas would find their way into the air, a difference in rate which would more than cover the slight difference in the limiting proportions of explosion, and very little experiment will clearly prove that acetylene cannot in any way be looked upon as more dangerous to property than coal gas.

The field for acetylene at the present time is simply enormous, as not only is it specially adapted for the lighting of country houses, and small villages and towns where no coal gas supply at present exists, but it will probably in the near future take the place of existing forms of lighting in railway carriages, tramcars, floating buoys, &c., whilst as an auxiliary to the electric light for lighthouses, search lights, and coast defence, it will I believe be of the greatest possible value.

Should any cheapening of the production of the calcic carbide take place, there is even a larger sphere of usefulness awaiting it, a sphere moreover in which the troubles found in the consumption of acetylene *per se* will entirely disappear. There are many places in this country where the cost of good gas coal makes coal gas prohibitive in price, whilst on the Continent these troubles exist to a far greater extent, and if it were commercially possible to use acetylene as an enricher of a cheap fuel gas an enormous field would be opened up.

When acetylene was first rendered a commercial possibility, numbers of experiments were made in order to see if this could not be done, but the results were most discouraging, as instead of each 1 per cent. of acetylene added to the diluting gas giving a value of about two candles, it was found that it was necessary to add something like 10 to 15 per cent. before the mixture became endowed with any luminosity at all, and that with water gas, an admixture with 20 per cent. of acetylene was necessary to give anything approaching a 20-candle gas. With a poor coal gas, however, the enrichment value of the acetylene gives better results, but still not sufficiently good to hold out any great hopes of acetylene replacing oil as a means of enrichment.

This curious phenomenon of high illuminating value when consumed by itself being reduced so enormously when the gas was used as an enricher, led me to make a long and exhaustive series of experiments on the causes which led to it, and I have now found the reason for this apparent anomaly, and also a way in which it can be obviated. The result is that it would be perfectly easy by a simple and rapid process to make a fuel gas costing from 8d. to 1s. per 1,000, and by the addition of 10 per cent. of acetylene to raise this to an illuminating value of about 20 candles, a result which, given cheap carbide, would open up an enormous use for acetylene gas.

For use in country houses, or generally for domestic illumination, it has been proposed to dilute the acetylene by means of air, apparatus for making the mixture of acetylene and air having been tried both in this country and in America, but so wide is the explosive range of mixture of this character, that any such apparatus would be of the most highly dangerous nature, and should anyone from want of knowledge be willing to adopt it, I should expect that the insurance companies would firmly prevent their introduction by declining to insure buildings in which such methods of illumination were adopted. It is perfectly easy to make a mixture of acetylene and air which will burn with fine effect and a non-smoking flame, but the apparatus employed to give such a mixture is always liable to get out of order, and an alteration in the proportions in which the gases were mixed might lead to the most disastrous results. A safe method of attempting this is to make an acetylene burner in which, in the burner itself, the gas escaping through an injector shall draw in the necessary amount of air for its consumption, but all the burners that I have seen on this principle have the drawback of requiring a high pressure of gas in order to work satisfactorily, whilst even then the results obtained from them are of a very variable character, and smoking by no means an unknown thing.

Any other diluent than air would require special apparatus for its production, and this would do away with the charm of simplicity in manufacture which renders acetylene so well adapted for illuminating country houses. It is well known that the carbides of some metals give on decomposition by water at a slightly elevated temperature other hydrocarbons, and in some cases mixtures of hydrocarbons and hydrogen, and if such carbides be mixed with the calcic carbide, the heat of the decomposition of the calcic carbide by water, and the slaking of the lime produced causes the decomposition of the other carbides present, and you get a mixture of gases evolved which can be made to approximate to the composition of coal or oil gas. Taking, for instance, the carbide of calcium and aluminium, you obtain a mixture of marsh gas and acetylene, which, whilst giving a magnificent illuminating power, can be consumed without fear of smoking, whilst if the carbide of manganese be used instead of the carbide of aluminium for mixing with the calcic carbide, a mixture of marsh gas, hydrogen, and acetylene can be got, and possibly when the best method of forming carbide has been obtained, it will be found preferable to use mixed carbides of this character rather than calcic carbide by itself.

PINTSCH'S GAS.

Position.	Double burner.		Single burner.	
	Gas rate, 1·8 c.f. per hour.	Pressure 1·5 inches.	Gas rate, 1·0 c. f. per hour.	Pressure 1·25 inches.
	Candle-power mean of tests.	Candle-power per foot.	Candle power mean of tests.	Candle power per foot.
Horizontal	18·86	10·477	8·56	8·56
5	18·86	10·477	8·56	8·56
10	18·62	10·344	8·56	8·56
15	18·06	10·03	8·51	8·51
20	17·60	9·77	8·34	8·34
25	17·46	9·70	8·26	8·26
30	17·42	9·67	8·16	8·16
35	17·40	9·66	7·94	7·94
40	17·22	9·56	7·80	7·80
45	16·04	8·90	7·54	7·54
50	15·04	8·35	7·30	7·30
55	14·08	7·8	6·96	6·96
60	13·08	7·26	6·50	6·50
65	12·22	6·79	6·04	6·04
70	11·50	6·39	5·53	5·53
75	10·0	5·55	4·96	4·96
80	9·0	5·00	4·48	4·48

Comparative experiments have been made on the utilisation of acetylene and oil gas in railway carriage illumination, and it gives for this purpose a most brilliant light, as the source being well above the range of vision, the carriage is flooded with light without any irritation being caused to the eyes. I have travelled in a carriage lighted in this way by the Acetylene Illuminating Company, on one of our principal lines, and the ease with which the half-penny press could be read and trains looked up in a Bradshaw throughout the whole journey indicated that the light was amply sufficient in every part of the carriage.

For railway carriage lighting compressed oil gas and not coal gas is employed, and in order to test the relative value of acetylene to this illuminant, I obtained a cylinder of Pintsch's gas, as used on the South-Eastern Railway, and consumed it in a lamp and fittings of the same character as those employed on the line. This gas when burnt in the burner most suited for its consumption gives an illuminating value of 52 candles or 10·4 per cubic foot of gas consumed, whilst the preceding Table gives the values obtained by burning it at a double and single burner in a carriage lantern fitted with reflector.

A cylinder of acetylene made from calcic carbide by the action of water was pumped by Messrs. Pope, and was then tested when burning from a 1 cubic foot burner, and also from a ½ cubic foot burner in Pope's lantern fitted with Thomas's reflector, the results being as follows:—

ACETYLENE GAS.

Position.	Large burner.		Small burner.	
	Gas rate 1·0 c.f. per hour.	Pressure 2·0 inches.	Gas rate 0·5 c.f. per hour.	Pressure 2·0 inches
	Candle-power mean of tests.	Candle-power per foot.	Candle-power mean of tests.	Candle-power per foot.
Horizontal	26·0	26·0	8·6	17·2
5	26·0		8·6	17·2
10	27·0		8·6	17·2
15	27·2		8·6	17·2
20	27·6	27·6	9·08	18·16
25	27·4		9·04	18·08
30	27·1		9·00	18·00
35	26·9		9·28	18·56
40	25·9	25·9	9·08	18·16
45	25·0		8·76	17·52
50	23·0		8·54	17·08
55	21·1		8·00	16·00
60	20·1	20·1	8·00	16·00
65	18·2		7·50	15·00
70	15·65		7·30	14·60
75	14·30		6·50	13·00
80	12.20	12·20	4·50	9·00

The illuminating power of the 1 cubic foot burner was in this case only 26·0 candles on the horizontal instead of 32 as in a previous experiment with pure acetylene, and as this loss of light seemed greater than one would expect by absorption by the glass globe, the gas was analysed and found to contain 10 per cent. of air.

This is of course due to the cylinder having been filled for experimental purposes, the difficulty of washing the pumps, pipes, and cylinder free from air for a single operation being very great, whereas in regular working 2 per cent. of air or other impurities would be about the limit. This being so it seemed fairer to make a fresh sample of the gas and repeat the observations under conditions similar to those which would exist in practice.

The gas contained 97·8 per cent. of acetylene, and the results obtained with the 1 cubic root burner in the Pope's lantern were :—

Rate of consumption—1·05 cubic feet.
Pressure in inches—2·0 ,, ,,

Angle.	Candle-power.	Candle-power per cubic foot of gas consumed.
Horizontal.	32·00	30·47
5	32·00	30·47
10	32·00	30·47
15	32·00	30·47
20	33·00	31·42
25	34·00	32·38
30	33·00	31·42
35	32·50	30·95
40	32·00	30·47
45	31·60	30·09
50	30·00	28·57
60	28·00	26·66

An ordinary railway carriage is from 5 feet to 5 feet 9 inches in width, and 8 feet from door to door, whilst the flame is, as a rule, about 7 feet from the floor, the seats being from 15 to 17 inches in height, which would bring the paper or book one was trying to read as nearly as possible 3 feet from the floor. This gives an angle of from 45 to 50° as the important one for the rays which are to be utilised.

These results are also confirmed by the tests made by engineers on some of the principal lines, who find that for railway carriage illumination acetylene is from four to five times as valuable as the oil gas usually employed, and there is no doubt that this brilliant illuminant is destined to play a most important part in our future methods of lighting.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

JANUARY 20.—"The Roller Boat of Mons. Bazin." By EMILE GAUTIER. SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., will preside.

JANUARY 27.—"Voice Production." By WILLIAM NICHOLL. Dr. C. HUBERT PARRY, Director of the Royal College of Music, will preside.

INDIAN SECTION.

Thursday Evenings :—

JANUARY 28, at 4.30 p.m. — "The Moral Advance of the Peoples of India during the Reign of Queen Victoria." By WILLIAM LEE-WARNER, M.A., C.S.I., formerly British Resident in Mysore, and Chief Commissioner of Coorg. The Right Hon. the LORD HERSCHELL, G.C.B., D.C.L., will preside.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock :—

JANUARY 26.—"The Artistic Treatment of Heraldry." By W. H. ST. JOHN HOPE, M.A.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

WILLIAM BURTON, F.C.S., "Material and Design in Pottery." Four Lectures.

LECTURE I.—JANUARY 18.

Simple Earthenwares.—Plasticity *the* characteristic property of clay—Its influence on the shapes of pottery vessels—On the methods of manufacture, by shaping, throwing, and pressing—On the methods of decoration, by modelling, carving, incising, inlaying, and painting—The use of natural clays entirely confined to simplest kinds of pottery—Primitive pottery of all periods—The so-called Samian ware of the Romans—Mediæval sgraffito—Inlaying, as in encaustic tiles—Early slip-decorated wares—Introduction of glazes—Addition of other mineral substances to the natural clays—Modifications produced in the clay by such additions, both before and after firing, leading to alterations in the processes of making and of decorating—The evolution of fine earthenwares, stonewares, and porcelains.

LECTURE II.—JANUARY 25.

Faïence and Fine Earthenwares.—The use of colouring matters other than naturally coloured clays leading to a widespread desire for a white ground on which to display such colours—How this problem has been solved in various countries and at different periods—Siliceous slip—Tin enamel—Clays white throughout their substance—Influence of these various devices on (*a*) the form, (*b*) the methods of fabrication, (*c*) the decoration ; examples—Persian faïence, Italian majolica, Delft, English earthenware

—Increasing refinement of material leading to mechanical perfection of manufacture, and to more elaborate, more naturalistic, and finally more mechanical decoration — Variations in style and method of decoration invariably preceded by alterations in material and method of its preparation—The mistake of treating fine earthenware as a kind of inferior porcelain, and its results.

LECTURE III.—FEBRUARY 1.

Stonewares.—The results of adding sand to a natural clay; diminution of the plasticity; loss of the more subtle curves, and consequent clumsiness of thrown stoneware shapes—Extended use of *pressing* in moulds, the moulds being generally of pewter or brass, early stoneware shapes are frequently those proper to metal, very distinctly so with the German stonewares—Stamped ornament, incised and scratched ornament particularly applicable to stoneware, which, from its refractory nature, retains the utmost sharpness of detail unimpaired after firing—The various kinds of stamped ornament—Unglazed and glazed stonewares—Salt glaze and its special qualities—Salt-glazed stoneware one of the most perfect forms of pottery—The limited use of colour on stoneware—The position of stoneware in relation to the other varieties of pottery—The stonewares most nearly approaching porcelain—White English salt-glazed ware—The stonewares of Josiah Wedgwood.

LECTURE IV.—FEBRUARY 8.

Porcelains.—The results of adding fusible materials to a natural clay: effects on the plasticity; effects on the fired body; effects on the nature of the glaze—Porcelain the connecting link between pottery and glass—Oriental porcelain and its distinctive qualities—The various attempts made to reproduce it in Europe —Artificial or soft-paste porcelain—Hard-paste porcelain—Working qualities differing from those of other forms of pottery—The extended use of the mould in throwing—The introduction of casting—The efforts made to take advantage of the translucence of porcelain—The artificiality of the European product—An outlying member of the pottery family—The modifications of the potter's methods to meet its qualities —The re-action of such modifications on the methods used for ordinary pottery—The influence of porcelain on the native pottery of Europe.

HOWARD LECTURES.

Thursday Evenings, at Eight o'clock :—

PROF. JAMES A. EWING, M.A., F.R.S., "The Mechanical Production of Cold." Six Lectures.

JANUARY 28.—LECTURE I.—Thermodynamic principles in refrigeration—The reversed heat-engine or heat-pump—Efficiency depending on range of temperature—Use of entropy diagrams—Co-efficient performance in ideal cases—The refrigerating machine as a heater.

FEBRUARY 4.—LECTURE II.—Types of machines —Machines using air as the agent—Regenerative process—Reversed Joule engine—Vacuum machines —Absorption machines—Present-day types.

FEBRUARY 11.—LECTURE III.—Modern vapour compression machines—Agents used—Theory of the process—Influence of temperature—The critical point —Comparison of ideal performance with various agents.

FEBRUARY 18. — LECTURE IV. — Modern machines: their construction and practical working—Ammonia machines: Linde, &c.—Sulphurous acid machines: Pictet—Carbonic acid machines; Windhausen, Hall—Compressors, condensers, refrigerators.

FEBRUARY 25.—LECTURE V.—Tests of performance of refrigerating plant—Trials by the Munich Commission and others—Industrial applications—Cold storage and transport—Cooling of air and liquids—Ice making: ice rinks—Distribution of cold from central stations.

MARCH 4.—LECTURE VI.—The production of very low temperatures—Liquefaction of "permanent" gases—Compound cycles—Method of Linde and Dewar—Linde's process of producing oxygen by liquefying air—Recent low-temperature research.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 11...Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. A. M. Brice, "Recent Polar Exploration."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. Howard Martin, "The Future Development of 'The Surveyors' Institution.'"

British Architects, 9, Conduit-street, W., 8 p m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m Mr. H. T. Harrison, "Electric Apparatus as used in Photography."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. W. H. S. Aubrey, "William Hogarth—Historian and Satirist."

TUESDAY, JAN. 12...Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W. 8 p.m.

Photographic, 12, Hanover-square, W., 8 p.m. Dr. Hall-Edwards, "Photography by the Roentgen Rays up-to-date."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Colonial Institute, United Service Institution, Whitehall, S.W., 8 p.m. Sir Sidney Sheppard, "The Administration of Justice in South Africa."

Asiatic, 22, Albemarle-street, W., 4 p.m.

WEDNESDAY, JAN. 13...SOCIETY OF ARTS, John-street, Adelphi, W.C., 7 p.m. (Juvenile Lectures.) Mr. C. T. Dent, "The Growth and Demolition of Mountains." (Lecture II.)

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m.

THURSDAY, JAN. 14...London Institution, Finsbury-circus, E.C., 6 p.m. Mr. F. J. Sawyer, "The History of the Dance and its Music" (with Terpsichorean and Musical Illustrations).

Royal, Burlington-house, W., 4½ p.m.

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

On Wednesday evening, 13th inst., Mr. Clinton T. Dent, F.R.C.S., delivered the second and last lecture of his course on "The Growth and Demolition of Mountains," in which he likened the process of disintegration in the mountains to that going on in the London streets by the accumulation of grit, dust, and mud, for as the rain wore away the roads, so it was a chief cause of the wasting of the mountains. Although there was no traffic on the mountains as in the London streets, it would be found that the effects of the glaciers were far more destructive. The glacier flows like a river, and moves at the rate of up to two feet in the twenty-four hours. This movement was proved by the alteration in the straightness of the dust bands, which were deformed by reason of the middle of the glacier flowing quicker than the sides. At the sides there is friction caused by the contact of the glacier with the sides of the mountain, which were polished by this means.

The lecturer referred to certain marks on the face of the rocks which had not hitherto been noticed, and he showed views of rocks so marked, to illustrate this point. On one occasion he asked his guide if he had noticed the marks, and could account for them. The guide answered that he had not noticed them before, but he supposed that the moraine had engraven its name on the side of the mountain. In order to prove the wide extent of these marks, the lecturer showed a view of a valley where there had once been a glacier, and where the horizontal marks were seen.

The lecturer then passed on to consider the effects of the avalanche in the demolition of mountains. Of the various kinds, that of snow dust did little harm to the mountain, but the ice avalanche was more destructive. Several illustrations were given of the falling of avalanches, and of the wide-spread destruction which they caused.

Destruction was also caused by the bursting of mountain lakes, such as the Marjelen See, near the Aegischhorn, but it was not to be forgotten that ice and snow might also act as a preserver, for when the snow formed a coating to the mountains and the temperature was uniform, the rock itself was protected and little injury was done.

A large number of lantern slides were shown, and the lecturer illustrated his subject by relating some of the legends of the mountains.

The Chairman (Mr. Francis Cobb) proposed a vote of thanks to Mr. Dent for his interesting course of lectures, which was carried unanimously.

HOWARD LECTURES.

A course of six lectures on "The Mechanical Production of Cold," will be commenced on Thursday evening, 28th inst., by Professor James A. Ewing, M.A., F.R.S., and will be continued on the following five Thursday evenings.

Admission to these lectures is on the same conditions as to the Cantor lectures, each member having the right of admission for himself and a friend.

Miscellaneous.

RUSSIAN TEXTILE INDUSTRY.[*]

Silk.—The Russian silk industry, founded at Moscow in 1848 by Lyons emigrants, now works up more than 40,000,000 francs (£1,600,000) worth of raw silk, imported from Europe or the East. It is almost exclusively concentrated in the Moscow government, which in 1885 contained 148 factories, with 8,874 looms, producing goods valued at more than 7,000,000 roubles (£1,120,000), besides 72 small factories whose production does not reach 1,000 roubles (£160), and in the other governments, 25 factories, the production of which attains a million roubles (£160,000).

Ribbons.—This industry, which is protected by a high customs' duty, has made great progress during the last few years, the annual production of the

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[*] From a communication by F. O. Lami to the *Industrie Textile.*

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factories, all in the Moscow government, now attaining a value of 600,000 roubles (£96,000).

Cotton.—In 1885 American cotton was first sown at Ferghana, in Asiatic Russia; and in 1887 the plantations acquired some importance. The cleaning of cotton occupies 17 factories, the production of 1890 being 300,000 poods (4,823 tons). In 1892 there were 3,000,000 spindles and 191,290 looms, the industry occupying 639,000 men, 210,000 women, 8,200 girls, and 18,000 children. The factories, which are chiefly situated at Moscow and in the governments of Vladimir, Tver, and St. Petersburg, produce cotton goods to the value of 260,000,000 roubles (£41,600,000).

Wool.—Russia, which occupies the first rank in Europe as a producer of wool, possesses 45,000,000 ordinary and 15,000,000 merino sheep, chiefly in the south, thanks to the extensive pasturage and temperate climate, which permits of keeping the flocks out in the fields during most of the year. The annual production of wool amounts to about 10,000,000 poods (178,457 tons), giving six pounds of wool to each sheep. Spinning mills in the governments of Moscow and St. Petersburg numbered 68 in 1885, occupying 4,789 workers, and producing a value of more than 5,000,000 roubles (£800,000).

Cloth.—After the government of Moscow, those of Tver, St. Petersburg, Warsaw, Lods, and Kharkoff are chiefly engaged in this industry; and there are in European Russia nearly 450 factories, occupying 50,000 hands, and producing cloth valued at more than 45,000,000 roubles (£7,200,000).

Felt.—Although this manufacture is unimportant, the factories of Nijni-Novgorod produce goods worth nearly 200,000 roubles (£32,000).

Flax.—More than 50 factories, employing nearly 3,000 workers, produce yearly more than 850,000 poods (13,665 tons), valued at nearly 4,000,000 roubles (£640,000). In 1893 there were 25 spinning mills, employing 200,000 hands, the value of their production attaining 16,000,000 roubles (£2,560,000).

Linen.—In 1893 there were 100 linen factories, with 7,000 looms, and 16,000 workers, which manufactured 1,000,000 pieces, valued at 800,000 roubles (£128,000).

Hemp. — This industry, dispersed through 31 governments, possesses 350 rope-works, with 7,000 hands, producing goods to a value of 600,000 roubles (£96,000).

A PATENT MUSEUM.

The following letter to the Editor of *The Times* from Mr. J. Sinclair Fairfax, President of the Society of Patent Agents, on the formation of a Patent Museum in connection with the Patent-office, appeared in *The Times*:—

Sir,—During the last few years several necessary additions have been made to the buildings of the Patent-office, others are in progress, and the Government are about to ask for power to acquire more property for further extensions. The cost of these operations in 1895 was upwards of £10,000; it was deducted from the surplus of £96,500 for that year, this sum being about the usual profit derived from the fees credited to the Patent-office.

Apart from the immense collection of British and foreign patent specifications to be seen at Southampton-buildings, the Patent-office library contains, perhaps, the finest collection of technical books in the country, and certainly none can be more accessible or convenient for reference. By simply signing his name and address at the entrance, the visitor is free to refer to any of the books there, and as they are arranged on the shelves according to their subject matter, one may often find the required information without even knowing the title of the work or the author's name. The rooms are open until 10 o'clock each week night. There is a mass of home and foreign technical periodicals on the tables, and the visitors average upwards of 2,000 per week.

My object in writing, sir, is to invoke your assistance in establishing a patent museum at the Patent-office, in which models of inventions, new materials and compounds, and products of mechanical and chemical operations can be seen and referred to as freely as their nature will admit. These should be typical illustrations of the more important developments of recent progress, together with such corresponding examples of their progenitors as may be obtained. The collection should form an index museum to the very useful classified abridgments of specifications compiled under the direction of the Comptroller-General. If judiciously selected, and with references to fundamental patents, the examples would indicate the evolution of prevailing ideas along the main thoroughfares of thought, thus guiding the inventor along paths found to be practical, and warning him against repatenting old devices. As our patent system does not provide an examination for novelty, it appears the more incumbent upon the Government to provide means whereby those interested may inform themselves of what has already been done; and, although the proposed museum could only do this to a limited extent, it should be supplemental to the library, and lead the searcher to the abstracts and specifications for the fuller knowledge.

Out of the aforesaid surplus I suggest that £5,000 per year be set apart to establish and maintain the proposed museum; the rooms, lighting, warming, and attendance being provided for as part of the ordinary expenses of the Patent-office. If it be objected that adequate space cannot be found on the site of the buildings, it may be pointed out that ample room for many years to come is already available by putting a glass roof over the lower portion of the courtyards within the area, and other convenient spaces for extensions could be mentioned.

The persistent attacks in the Press on the old "Brompton boilers" led to the transfer of the former

Patent Museum to the Science and Art Department, when the Patents, Designs and Trades Marks Act of 1883 came into force. The collection of interesting relics and valuable models was removed to the less accessible exhibition galleries, which, being closed at dusk until quite recently, greatly impaired their usefulness to the class for whom they were originally brought together. Many of the models are of beautiful workmanship, and in that respect alone are highly interesting and instructive to workmen. The beam engines of Watt and the early locomotives should remain where they are; but some of the smaller examples, with models of machines and mechanical motions, would form a sufficient nucleus. At the Patent-office the proposed museum would be in the most central and appropriate place in the metropolis; and apart from its use to all concerned with inventions, it would form a technical museum of great value, illustrating many branches of industry.

Through Sir Reader Lack and the officials at the Patent-office the Board of Trade have successfully administered the present law, the various presidents of the Board since Mr. Chamberlain, as well as the Treasury, consistently following out the policy of encouraging inventors adopted in 1883. The steady increase of the business of the office and the unprecedented number of patent applications in 1896 appears to fully justify that policy. In applying to Parliament for the power above referred to it appears to be a fitting time to modify section 41 of the Patents, &c., Act of 1883, and empower the Board of Trade and the Treasury to construct the necessary rooms and establish the museum at the Patent-office out of its surplus revenue. If anything further need be said of the industrial value of such a museum, it is best done by referring to the immense interest shown by all classes at the Chamber of Commerce rooms, where foreign manufactures, brought together by the Secretary for the Colonies, were exhibited. Many foreign inventions of merit are patented in this country, which should find a place in the proposed museum; and your support for the project is asked in the belief that the small expenditure required would prove an investment of a reproductive character.

ABEL JANSZOON TASMAN'S VOYAGES.

Mr. James B. Walker contributed to the Royal Society of Tasmania a careful account of the life and voyages of Tasman, which has been issued in the last publication of the papers and proceedings of the society. The author regrets that in spite of patient research the result is somewhat disappointing. The facts are mostly dry and meagre, gathered from formal official despatches and dusty registers. Personal details are few, so that the man himself remains for the most part an indistinct figure. The material is wanting for a biography which would give a clear and sharply-defined picture of the man as he lived. We can, however, arrive at a just estimate of his work as a discoverer, and of his place among the great navigators of the world. The discovery of Tasmania and New Zealand was no chance adventure. It was the result of a steady policy, and the outcome of the adventurous energy which in the 16th and 17th centuries created the Dutch Republic, gave to Holland her colonial empire, and sent out her sailors to search for a new world in the unknown regions of the mysterious south. Tasman and Visscher are but types of the men who won for their country her once proud position. No life of the first circumnavigator of Australia has hitherto appeared in English, and nothing has been accessible to the English reader but an abstract of one voyage, and a few lines in biographical dictionaries. Fifty years ago, all that had been printed in his own country consisted of short abstracts of a few voyages, and these well hidden away in bulky collections. Even the date and place of his birth were matter for conjecture and dispute. Thirty-five years ago the complete journal of his famous voyage of 1642 was published in Holland, and a facsimile of the original manuscript is now promised, with notes, by two eminent scholars, and with an English translation.

Abel Janszoon Tasman was born in the year 1603, in the little inland village of Luytjegast, in the province of Groningen, the most north-easterly province of Holland, and part of the ancient Friesland. Nothing is known of his early life, but he seems to have settled in Amsterdam for a time. When he was about 28 or 29 years old he made what was probably his first voyage to the East Indies, in the service of the Dutch East India Company. Mr. Heeres has found two declarations signed by Tasman in 1634, which show his rapid rise, during the space of two years at most, from the position of a simple sailor to that of master of a ship. In May he was mate of the *Wasp*, trading from Batavia, in Java, to Amboyna, in the Moluccas. In July the Governor of Amboyna appointed him skipper of the *Mocha*. In August, 1635, he was "Commandeur Abel," cruising at the head of a fleet of small vessels, to protect the jealously guarded monopoly from foreign intrusion, and generally to harass the ships of hostile Europeans in the waters of Amboyna and the Banda Seas. After describing Tasman's early voyages to 1638, Mr. Walker gives an account of his voyages in Japan seas, 1639-1642. In the latter year began the great discovery voyages to the unknown southland. Anthony Van Diemen became Governor of the Dutch East Indies in the years 1636, and his zeal for discoveries, which might bring increased wealth and power to the Dutch, was unbounded. In his plans for the projected voyage of discovery his chief adviser was Frans Jacobsen, *alias* Visscher. In January, 1642, Visscher wrote a report to the Governor-General, which is described as a masterly document, and the decree for the expedition is dated 1st August, 1642. The expedition was to consist of two ships, the *Heemskerck* and the *Zeehaen* (Cormorant), and to be under the command of the Hon. Abel Tasman; with him were to be associated Pilot-Major Visscher, and other capable officers. The ships sailed from Batavia on the 14th August, and on the 24th November they sighted the country, which they called Anthony Van Diemen's land, after the Governor-General. Tasman returned to Batavia on 15th June, 1643, having circumnavigated New Zealand, or, as he called it on his chart, "Compagnies Nieuw Nederlandt," and found a clear way to Chili.

Another voyage was undertaken in December, 1644. Tasman and Visscher instead of sailing first to New Guinea, make a straight course to the land of Eendragt. From thence they coasted northwards, and carefully charted, with soundings, the west and north coast of Australia, including the Gulf of Carpentaria. Tasman got into the mouth of Torres Strait, but did not discover the passage. He returned along the south coast of New Guinea to Batavia, where he arrived in August, 1644.

Van Diemen was disappointed with the results, and Tasman's services were grudgingly recognised. Van Diemen died in 1654, and with him, Mr. Walker says, the era of discovery expeditions closed. Tasman's later years from 1644 to 1659, in which year he died, are then described, and the author sums up as follows:—"Tasman's discoveries, great as they were from a geographical point of view, bore no fruit for more than a hundred years. His tracks were marked on the charts, but as to the countries he discovered, his countrymen in the East Indies, whose sole object was trade, felt no temptation to explore the wild bush of Van Diemen's Land, or to face the fierce tribes of Massacre Bay, or even to plant colonies on the barren and inhospitable shores of Western Australia, peopled by naked savages. Only the Englishman, Dampier, in 1688, and again in 1699, visited the western coast, and was glad to leave what he described as the most miserable country on earth. Had Tasman but discovered the way through Torres Strait, it is possible that New South Wales might have been colonised by the Dutch."

The author explodes the little romance first suggested by Flinders that Tasman was attached to a daughter of Governor-General Van Diemen, as evidenced by his naming various places, *e.g.*, Cape Maria Van Diemen, Maria Island, Maria Bay at Tonga. Van Diemen had no daughter and Tasman attached to one of the drawings in his journal the statement:—"We have named this bay Maria Bay, in compliment to the wife of Governor-General Van Diemen." Mr. Walker has added three facsimiles of maps. (1) Mappe monde circa 1630, showing the Terra Australis nondum cognita, as supposed before Tasman's discoveries; (2) map of Tasman's voyages, 1642 and 1644; (3) map of Anthony van Diemenslandt. In the same volume of Proceedings of the Royal Society of Tasmania is a facsimile copy of a chart showing the tracks of Tasman in his voyages of 1642 and 1644, preserved in the British Museum, with a note by A. Mault.

MANUFACTURE OF YEAST IN HOLLAND.

As in most other industries, foreign competition is now to be largely contended with in the manufacture of yeast, and probably there is no factory, either abroad or at home, whence this commodity is turned out in such large quantities as that of the Netherlands Yeast and Spirit Company in Delft, a town noted almost from time immemorial for its pottery ware. This ancient Dutch town, situated within six miles of the Hook, and claiming about 30,000 inhabitants, is likely to be better known at no distant date, as being chiefly remarkable not only for producing yeast, but also for having been the seat of perhaps the most successful attempt yet made to bring about a thorough harmony between capital and labour. Commencing comparatively few years ago, and in a small way, these works have now grown into huge proportions, employing, besides about 400 hands, the most approved appliances, and yielding nearly 100 tons of yeast per week, a very large proportion of which finds its way into these islands.

A brief description of this factory, which we recently had an opportunity of inspecting, will no doubt prove of interest to a number of our readers. Situated as it is, with railway and canal service intersecting the premises, no situation could be more favourable for a good and cheap supply of fuel and grain. The latter, comprising barley, rye, and Indian corn is raised direct from barges by endless conveyors to the top of a large storage warehouse. From this height it is allowed to gravitate into tanks, through which powerful currents of air are blown. From these tanks the grain is conducted, as required, on endless bands into the mills for treatment; but before being ground the barley is malted, to develop in the grain, by means of germination, the saccharificating ferment, diastase, which will in turn transform later on, in the process of maceration, the farinaceous matter into glucose.

After being allowed to soak from 24 to 48 hours in cold water, frequently renewed, the barley is spread out in thin layers on vast melting floors, the superposed shelves of which are supported on iron columns. By this means the barley is converted into malt, and is then ready for drying. This process takes place in kilns, heated by means of a stove at the bottom, so that, the grain being admitted at the top, where the temperature is lowest, is allowed to gravitate to the bottom, where the greatest heat is encountered. From these kilns the grain is again taken by means of conveyors to a cleaning chamber. The process of maceration takes place in large wooden tubs, and in an adjoining chamber the fermentation tubs are placed. Into these latter tubs is introduced with the saccharified pastes a fermenting agent, previously prepared by the mixture of yeast and flour. The fermentation process is not limited to the transformation of the sugar into alcohol, but also evolves the yeasts which are the chief product of this factory. These are collected in a frothy state on the top of the liquid and conducted through channels into a common reservoir. By next passing them through sieves they are cleansed, then collected in a milky state, and after repeated washings in clean waters are transported to filter presses, by means of which the excessive moisture is expelled, leaving a solid cake. It should be stated that the spirituous liquor forming the by-product in this process, after being drawn off and rectified, is bottled by special machinery and sold as Hollands gin.

A factory turning out such an enormous amount of material necessarily involves the employment of a large amount of plant, and this has all been arranged by the directors, Messrs. Van Marken and Mr. F. G. Waller, to whom great credit is due for the admirable appliances—many the inventions of the latter—which are designed to give the highest possible results with a minimum of labour. The steam required in the processes is derived mainly from a battery of twelve large Lancashire boilers, but high-pressure steam is also supplied by a pair of Babcock and Wilcox steam generators. The exact amount of fuel burnt and water evaporated in the boilers is ascertained, the latter being measured by an automatic water meter of Mr. Waller's own design. The fuel used is common slack, involving the employment of hand stoking. An incentive in the shape of a weekly bonus is paid to the stoker who obtains the best results from his firing, the results being arrived at by the analysis of the chimney gases; thus the carbonic acid gas, as it passes up the flue to the chimney, is collected in an ingenious apparatus, patented by Mr. Waller, from each group of boilers, and a premium is paid to the stokers according to the amount they produce above a given percentage of the chimney gases.

The works are situated in the beautiful Agneta-park, some fourteen acres in extent, in which are also erected the principal director's residence, cottages for the *employés*, a school for the children, library, gymnasium, co-operative stores, and a printing works, the whole forming a practically independent community. It would occupy too much of our space to describe the various schemes which have been instituted for the benefit of the *employés*, but we may briefly enumerate a few of the principal of these. First, there is a profit-sharing scheme, by which every individual benefits from the prosperity of the company in proportion to his wage, the company devoting 10 per cent. of its profits to the purpose. In addition, every *employé* may become a shareholder in the company by purchasing special small shares of the value of 10 fl. There is a savings' bank, which allows 5 per cent. on all voluntary deposits, and a premium savings' bank allowing 4 per cent. on obligatory deposits out of premiums and profit shares. The *emyloyés* may also become their own landlords by purchasing through the agency of a joint-stock company the houses in which they reside, while funds are established whereby benefits are derived in case of accidents, old age, death, fire, &c.

Perhaps the most important social institution is an association called "the Kernel," the *motif* of which is the furtherance of good relations between the company and its *employés*. This Kernel, which resembles a small Parliament, is divided into three chambers:—(1) The chamber of managers—the members of which are the managers of the different departments of the works—twelve in number; (2) the chamber of foremen and chief clerks, having as members the two oldest hands, in point of service, and six others elected by their equals in rank; and (3) the chamber of labour, comprising the four eldest workmen and twelve others elected by the hands. Each of these chambers elects its own chairman and secretary, and the reports of the meetings are submitted to the directors, while a half-yearly general meeting of the Kernel, presided over by one of the directors, decides all questions which have to do with the *employés*. A novel arrangement of arbitration between the directors and *employés* has been devised. The arbitrators are five in number, consisting of two employers of labour appointed by the directors, two workmen not belonging to the works, but selected by the hands, and a president elected by the above four, but neither an employer nor a workman.

As to whether such elaborate social schemes, of which we have only attempted a very brief description, could be carried out in large factories in this country, we do not feel disposed to express an opinion, but we are convinced, from a personal visit to the Netherlands Yeast and Spirit Manufactory, that the systems there in vogue, and which have now been at work sufficiently long to form a practical test, are giving perfect satisfaction to all concerned, and reflect the greatest credit upon Mr. J. C. Van Marken, the founder of the works, who has been mainly instrumental in their conception.—*The Engineer*.

BURMA TEAK FORESTS.

Sir Dietrich Brandis, K.C.B., F.R.S., who has lately been elected an Honorary Corresponding Member of the Society of Arts, has communicated to the New York *Garden and Forest* an account of the first introduction of regular forest management, forty years ago, in the Burma teak forests, from which the following particulars are taken:—

In January, 1856, I took charge of the teak forests of Pegu. Teak forests they are called, but the teak tree only forms a small proportion of the forest. In most cases trees form the upper story of the wood, while the lower story consists of a dense mass of bamboos, from thirty to sixty feet high. The constitution of these forests has of late years been carefully examined in a large number of districts, and it has been found that the proportion of teak to other trees, not counting bamboos, as a rule varies between ten and twenty per cent. Taking the bamboos into account, it may be said that teak hardly ever forms more, and, as a rule, much less than ten per cent. of the entire growing stock, The chief aims, which I had proposed to myself in 1856, were threefold: (1) To protect and, as far as possible, to improve the forests, to arrange the cuttings so as to keep well within the productive powers of the forests and to ensure a permanent and sustained yield from them. (2) To make the inhabitants of the forests and the people in the vicinity my friends and allies. (3) As soon as possible to produce an annual surplus revenue.

The province of Pegu had been annexed to the British Indian Empire in December, 1852, in consequence of a war which the then King of Burma had provoked. Lord Dalhousie, at that time Governor-General of India, was a real statesman. Rangoon, the capital of Pegu, had long been known as an important place for the export of teak timber, and Lord Dalhousie had determined that this source of wealth should not be wasted but should be preserved. I landed in Calcutta in December, 1855, and fortunately at once found opportunities for obtaining information regarding the state of things in Pegu, and for framing a general plan of action. The outline of this plan I had the honour of submitting to His Excellency. Lord Dalhousie listened with great attention, and when I had concluded, he said: "Dr. Brandis, if you succeed in carrying out these excellent plans, you will confer a lasting benefit upon the people of Pegu. I hope you may succeed, and you will have my full support in the matter. I hold it to be the duty of the Government of India to preserve the forest resources of Pegu, and not to allow them to be wasted as the forest resources of other provinces have been wasted."

Lord Dalhousie had selected the very best man for the government of the newly-acquired province, Major (afterward Sir Arthur) Phayre. Through the wisdom and determination of that great and good man, Pegu was speedily converted from one of the most unruly and wild countries into a flourishing and well-peopled country. What the population of Pegu was at the time of annexation is not known. In 1856 it amounted to 700,000, and in 1881 to 2,500,000.

Under the orders, and with the unchanging cordial support of Major Phayre, I gradually put my plans into execution. A few days after landing at Rangoon I selected a large area, with one and a quarter miles of river frontage, above the town, where I established a timber depot for the collection and sale of the timber to be brought down from the forests. At that time Rangoon was a small place and the land then made over to me for forest purposes was of little value; it is worth several millions now.

At annexation the teak forests had, by proclamation, been declared the property of the State, and this was in accordance with established custom, for under the King of Burma teak had been a royalty, all teak trees were the property of the King, and teak timber was a monopoly. So far the position of the Government was safe on paper. But I knew that something more was wanted, and that the most effective plan for acquiring full control of the forests would be to keep all operations in the forests in my own hands, to bring out the timber on Government account, and to sell it at Rangoon by public auction. This plan I hoped would enable me to give the inhabitants of the forests and the people who had hitherto done the work of dragging and floating the timber, profitable and steady employment, and thus would make them my friends and allies.

To establish a regular system in a forest of that description, where teak was the only marketable tree, obviously was a singularly difficult, nay, at first sight, an impossible task. Each teak tree cut would make room for valueless trees of other kinds, while less seed would be shed and consequently fewer teak seedlings would spring up. Under these circumstances one plan only was feasible—to cut sparingly, to select the trees to be cut with the greatest care, and simultaneously to increase the proportion of teak in the forest by planting. These essential points I kept in view from the very beginning, though, as regards planting, it was not possible to take action upon a sufficiently large scale, until several years later.

Cuttings, however, had to be made, in order to produce money. I knew perfectly well that unless the forests could be made a source of annual net revenue to the Government, regular forest management was not likely to be maintained. These cuttings, however, I was determined should be regulated by a well-considered plan, the object of which would be the maintenance and not the exhaustion of the forests. In order to prepare such a plan it was necessary to know the rate of growth of the teak tree, the quantity of growing timber in the forests, and the proportion of the different age classes in each district. In 1856 very little was known regarding the rate of growth of teak. The timber of that tree has well-defined concentric rings, marked like the annual rings of oak, ash, and other kinds, by a belt of numerous large pores. Subsequent researches have proved that these concentric rings actually represent a year's growth, the dry season being the period of rest corresponding to the winter of temperate climates. In 1856, however, this had not been fully established. Fortunately there were at the Botanic Gardens in Calcutta and in gardens elsewhere teak trees the age of which was known. These I measured, and these data, together with what was known regarding the rate of growth of the teak tree in Bombay and on the island of Java, enabled me to form a preliminary though very imperfect idea regarding the rate of growth of this tree.

It will now be necessary to explain that a teak tree before it can be cut must first be killed by girdling it. The only practicable method of bringing the teak timber of Burma to market is by floating it. To the water's edge the logs are dragged by oxen, by buffaloes, and by elephants. The dragging is done during the rains and the early part of the dry season, when the ground is moist and slippery, so that heavy timber glides easier. Down the smaller streams the logs are floated singly during the rains, and when they reach the main stream they are collected and formed into rafts. Teak timber has about the weight of oak or chestnut; unlike the wood of pines and other coniferous trees, it does not float unless it is perfectly dry, and from time immemorial this has in Burma been effected by girdling the trees. A broad circular cut is made through bark and sap-wood right into the dark brown heart-wood, which, when first cut, has a beautiful golden yellowish brown colour. In teak, as in all trees with a distinctly marked heart-wood, the sap ascends though the sap-wood only; hence, if the communication of the sap-wood below and above the girdle is interrupted, the tree is killed. Within two or three days the leaves wither and the tree dies. But if the smallest thread of sap-wood is left the tree continues to live. Timber well girdled dries completely and seasons evenly, for it is on all sides freely exposed to sun and wind. Smaller trees dry sufficiently if left standing after girdling for one or two years; larger trees must stand longer. When a teak tree is felled green that side of the trunk which is in contact with the ground takes a long time to dry, the timber seasons unevenly, it is less useful and less durable, and when thrown into the water it does not float readily.

In November, 1862, I was called to Calcutta to organise forest administration in the other provinces under the Government of India, but, though I no longer had charge of the Burma forests, I paid frequent visits to my old province and endeavoured as much as possible, to regulate the working of its forests. Thus, in 1868, I spent three months in Burma in order to prepare, with the aid of the local officers, a new working plan for the forests. Like that of 1856, this working plan was based upon the result of linear valuation surveys, and upon what was known regarding the rate of growth. The valuation surveys extended over 39,700 acres, or three per cent. of the area to which the working plan was intended to apply. The total area was divided into forty-seven districts under five main divisions, and upon the results of the valuation surveys, together with the knowledge which the local officers had acquired regarding each district, an estimate of the number of first-class trees in each district was based. For the entire area this estimate amounted to 934,000 trees, six feet in girth and upward. The estimate of 1856, it will be remembered, was for Pegu only. As regards rate of growth, convincing proof had been obtained that the concentric rings visible in teak timber actually represented one year's growth. For younger trees this proof was obtained by the examination of trees raised in the Nilambur plantations, the oldest of which were then twenty-five years old. For older trees, a fearful cyclone of October, 1864, had furnished the data; it had blown down a large number of old teak trees of known age planted near Calcutta, and sections of the stems were at once examined. Accordingly, the rate of growth was now based upon the counting of annual rings on butt ends of logs collected at the Rangoon timber depot. I will not weary the reader with details, suffice it to say that while the rate of growth assumed in 1856 was too rapid, that of 1868 was much too slow. No less that seventy-two years were supposed to be necessary to bring up a teak tree in the forests from a girth of four feet six inches to six feet, against twenty-three years in 1857. The second-class trees having also been found to be less numerous than those of the first-class, it was decided to spread the removal of the latter over a period of eighty years. Thus, the maximum annual yield was fixed at 11,600 trees against 24,300, the mean number actually girdled during the first period ending in 1868. This yield was fixed for five years only, because it was hoped that rapid progress would now be made in the selection and demarcation of the forests permanently to be maintained as such, and that when the boundaries of these forests had been laid down special working plans for each forest district would then be prepared.

One important fact must here be noted, which has greatly aided the realisation of a steadily-increasing revenue. When I commenced work in 1856 I found that all teak-producing tracts on the outskirts of the forests, and those in the hills which were near good floating streams, had been completely cleared out, the stumps alone of teak trees remaining with the half-burnt tops and branches of the trees. Large areas of teak-producing forest, however, had fortunately, been closed against the extraction of timber by obstructions in the rivers. These obstructions were of two classes. Some were caused by the silting up of mountain streams coming down from the hills with great velocity, carrying with them masses of sand silt and rubbish, which they deposited on entering the level country of the main valley. Some streams were more liable to silt up than others, and some of the richest teak localities near the open country had been protected by such obstructions. In the majority of cases it was sufficient to clear the silt away, but in some it was necessary to dig canals in order to regulate the course of the river, and thus to open it for the floating of timber. The other class of obstructions was caused by boulders and barriers of rock in the bed of the hill streams. A large extent of the most valuable teak-producing tracts in the hills had on that account never been worked. Early on my first tour in 1856 I had discovered and examined some of the most formidable of these rocky obstructions in two large tributaries of the Sitang River and had explored the forests on the hills drained by these streams. I then had formed my plans for the removal of these obstructions, but at that time my position was not sufficiently secure to take action. Beginning with 1858, however, blasting parties were employed for the removal of these obstructions. Men trained to that kind of work not being available in Burma, parties of Coringa workmen were brought across the Bay of Bengal from the Coromandel coast to start the work. The undertaking was not an easy one. The places where the rocks had to be blasted were in the midst of the forest, far away from any village, difficult of access, in deep, unhealthy valleys. Hence, after the Coringa men had done a few years' excellent work, the fever of the Burma jungles had decimated their ranks, and it became difficult to replace them by men from their own country. This difficulty I had forseen, and had associated with them a band of Red Karens, hardy, but most unruly, mountaineers, whom I had attached to me personally, who had been my most faithful followers and had enabled me to explore the forests rapidly and thoroughly. The Coringa blasters were Hindus, very skilful, intelligent, and exceedingly cautious. With them no accident had ever occurred. The Red Karens, on the other hand, were impulsive, bold, but exceedingly careless, and severe accidents became numerous. However, the work went on, and is being continued year by year to this day, gunpowder having been replaced by dynamite. The number of these rocky obstructions was very large, but gradually they are all disappearing.

The removal of these obstructions placed at my disposal a large extent of good teak localities that had never been touched by the axe of the lumberman, and fortunately the existence of this wealth of growing timber was unknown to my friends, the merchants of Rangoon.

It has already been stated that up to 1879-80 nearly the whole surplus revenue was derived from the sale of teak timber. In 1860, however, as soon as the financial success of forest administration in these provinces had been secured, large quantities of other woods, not teak, sound, carefully selected pieces of those kinds which were likely to prove useful, were brought down from the forests to Rangoon. At the monthly sales these timbers were sold at the Government timber depot, with the view of bringing other kinds of timber to public notice. At that time these operations yielded no profit, nor was this anticipated. They cost a good deal of money, but the object I had in view was attained. A demand gradually sprang up for several kinds, and, among others, one kind, *Pentace Burmanica*, a tiliaceous tree, formerly quite unknown to trade, was discovered to be useful for tea boxes and furniture. After I had left Burma in 1862 these operations were discontinued for some time; they were, however, afterward resumed, and yielded a small surplus of 30,000 rupees a year, on an average, during the three years ending with 1878-9.

Teak, like other trees, grows rapidly in some, slowly in other localities. The researches which were made regarding rate of growth in the thirteen districts, for which, up to date, special working plans have been prepared, have led to the conclusion that on the hills teak trees grown up under the regime of the annual jungle fires attain four feet six inches in girth at an age between 100 and 115 years, while trees six feet in girth are between 134 and 156 years old. Hence the time which a second-class tree requires to attain first-class size may, under these circumstances, be accepted on an average at thirty-eight years. This, we have seen, is the period over which it is intended, under the working plans lately prepared, that the girdling of the present stock of first-class trees shall be spread. It has previously been mentioned that the districts here described comprise a few small blocks situated in the plains. Here, the rate of growth is more rapid, but their area is small, and they may be neglected upon the present occasion.

As explained repeatedly, the annual yield of these forests has on three occasions been fixed—in 1856, 1868, and by means of the special working plans prepared between 1884 and 1892. In all cases was the yield based upon the estimated quantity of the growing stock of teak of the different classes, and upon the rate of growth assumed at that time. The following figures give the annual yield fixed on these three occasions for the eleven forest districts in the Irawaddi valley and the time supposed to be required on an average for a second-class tree to attain first-class size:—

	Trees.
The working plan of 1856 assumed 24 years, and fixed the annual yield at	9,000
The working plan of 1868 assumed 72 years, and fixed the annual yield at	5,800
The special plans, 1884 to 1892, assumed 38 years, and fixed the annual yield at	11,230

Those who have to break fresh ground in the matter of regular forest management will understand the satisfaction which the writer of these lines feels, that in 1856, when the data then at his disposal led him to credit the teak tree with a rate of growth much too rapid, he yet fixed the annual yield below what the forests are capable of yielding. Regarding the number of trees actually girdled in these districts during the 12 years from 1856 to 1868, in accordance with the working plan of 1856, there is some doubt. The returns give 153,856 trees, or 12,821 a year. In these districts girdling operations were conducted in 1857 and 1858, when no competent officers were available for supervision, and there is ground for believing that a much smaller number than that reported were at that time actually girdled.

It must be distinctly understood that under the working plans lately prepared the number of trees actually girdled will, to some extent, also be regulalated by area, that is, by the localisation of girdling operations. The yield sanctioned by the plan for a particular district is a maximum, which must in no case be exceeded, and which must not be worked up to, if in the area assigned to a particular period the full number of trees that under the rules laid down for their selection may be girdled, cannot be found on that area. Thus for the Thonzay district the plan of girdling has been laid down for a period of 30 years, divided into six sub-periods of five years each, To each sub-period have been assigned a number of compartments, in which during the five years fixed a maximum of 5,000 trees may be girdled. Thus, out of the 114 compartments 19 have been assigned to the first sub-period, 1885-9), while 11 compartments were assigned to the last sub-period (1910-14). In the compartments assigned to the first sub-period the older trees prevail, while the younger trees are more numerous in the areas assigned to the last sub-period.

Like the oak and Scotch pine, the teak tree demands much light. As already mentioned, it does not, as a rule, form pure forests, and it thrives best where the ground is protected by a dense underwood of bamboos, which forms a lower story of the forest 30 to 60 feet high. This underwood of bamboos is analagous to the lower story, which the beech, the hornbeam, and the silver fir in Germany, form under the oak or the Scotch pine, and which, according to Pinchot and Graves, in Pennsylvania the hemlock forms underneath the white pine. The bamboo, therefore, may be regarded as a useful companion, a friend and ally of the teak tree, but in young teak plantations it often is a most formidable enemy. The forest cleared by the Karens for their toungyas, to a great extent, is composed of bamboos. Each bamboo clump consists of two portions. Underground is an entangled network of rhizomes, while above ground rises the gigantic tuft of hollow wooded stems. The rhizome is not, as a rule, killed when the toungya is fired. During the first few years the rhizomes produce slender shoots, but gradually they recover their strength, and then all at once a number of stems grow up of the ordinary thickness, and at once attain their full height, which varies according to the species, *Dendrocalumus*, 30 to 40; *Bambusa polymorpha*, which is the species that prevails in the moister forests, from 52 to 60 feet. At that time, the young teak, if properly cared for, is extremely vigorous, the stems, 15 to 20 feet high, on the current year's shoot, four to five pairs of leaves two to three feet long and eight to ten inches broad. Weeds, seedlings, and coppice-shoots of other trees no longer endanger its existence, if the early cleanings have been carried out regularly, and the plantation seems safe. At that time, however, the bamboo shoots come up all at once in dense masses, the teak is over-topped, a large proportion of the plants is killed, some linger with a few miserable leaves under the dense shade of the bamboos, while others continue the struggle, but are mostly forced up into long, slender, weak stems. Here prompt and vigorous action is needed in cutting back the bamboos. Obviously, teak plantations, particularly those established on toungayas in the heart of the forests, require constant care until the teak has overtopped the bamboos, which is not generally the case before it is 15 to 20 years old. The bamboos associated with teak in the Burma forests have been compared to the companions of the oak in Europe, and the white pine in North America to the beech and the hemlock. But the life-history of the bamboo is very different. When the stems, which constitute the bamboo clump, have attained a certain age they produce flowers, and after ripening their seed they die off, and in most species not only all stems of one clump, but all clumps in one district, bear seed and die. The dead stems fall, and form a tangled mass of bamboos, through which it is hardly possible to force one's way. The fires of the next hot season, however, sweep away this dry mass, and when the rains set in the enormous crop of bamboo seed germinates, and the result is a carpet of young slender bamboo plants, a portion of which, after a series of years, grow up into clumps. Hence, the flowering and seeding of the bamboo is an event of great importance, which recurs after a certain number of years; thirty years in the case of some species, forty in the case of others. At that time, when the cover overhead is thus suddenly removed, the seeds of teak and other trees which have not been destroyed by the conflagration get a chance and grow up.

But apart from plantations and cultural operations, the natural forests are capable of great improvement. It has been stated that the area protected from fire in the reserved forests of the British Indian Empire amounts to one-third of the whole. In Burma the work of fire protection is much more difficult than in other provinces, and of the 6,374 square miles of reserved forests in Lower Burma, it has not yet been possible to protect from fire more than 8½ per cent. The protected area is increasing steadily, but slowly. As it increases the soil improves, less seedlings are destroyed, and a smaller number of large trees are damaged by fires. True, bamboos and other trees profit equally, but with the special care bestowed upon the teak, that tree profits more, and the result eventually will be a larger annual yield of teak timber from the same area. On several occasions in these pages the Karens have been mentioned as the most important inhabitants of the forests of Lower Burma. Their villages team with children, and under the strong and just British Government their numbers increase steadily. When the reserved forests were demarcated, certain areas were assigned to them in each forest district, sufficient to furnish forest for their shifting system of toungya cultivation, and calculated liberally, so as to provide for an increasing population. Many of these Karens are employed in planting teak on their toungyas, and thus they contribute materially to augment the future yield of the forests. The present yield of the natural forests under the special working plans made within the last twelve years amounts to seventeen trees girdled annually upon a thousand acres, or to less than two cubic feet per acre. As fire protection is extended, as larger areas are planted, this insignificant yield per acre will eventually be a thing of the past.

It has been stated that strong opposition was raised in the earlier days against the demarcation of reserved forests in Burma. Even some of the principal forest officers, after I had left Burma, supported this opposition, and their strongest argument was that the natural forests should be left to the Karens, and that for the supply of teak timber in the future we should exclusively rely upon plantations made, if possible, in the open country outside the forests. All mature timber in the forests could then be cut at once, and this would give a powerful stimulus to the trade and prosperity of the country.

Fortunately, these views did not at that time prevail. Slowly, but steadily, the forest revenue had increased. The merchants of Rangoon were as anxious as they had been in 1860 to get the forests into their own hands, or, at least, to girdle as much timber as they wished. But the steadily growing surplus revenue was accepted by the Government as proof that the system initiated in 1856 was a good one and ought to be maintained. And when in 1886 Upper Burma was annexed the good financial results of forest management in Lower Burma led to the adoption of a similar system for the new territory. The forests of Upper Burma are exceedingly rich. Large quanties of old timber, girdled by the holders of forest leases under the King, are being brought out, and it has been possible largely to continue girdling operations. The surplus forest revenue of Upper Burma is very large, amounting during the five years ending 1893-4 to 1,436,000 rupees a year.

The far-sighted forest policy laid down by Lord Dalhousie, and carried out by Sir Arthur Phayre, made it possible to initiate a good system. Its maintenance, however, is chiefly due to the growing surplus revenue. Nay, it is not too much to say that the Burma surplus forest revenue has largely contributed to the establishment and maintenance of a good forest policy in the British Indian Empire. The figures for the five years ending with 1893-4 stand as follows :—

Mean Annual.	Rupees. British India.	Rupees. Burma.
Gross revenue	15,949,000	4,978,000
Expenditure	8,603,000	1,672,000
Surplus revenue ..	7,346,000	3,306,000

The mean annual surplus forest revenue of Burma amounts to 45 per cent. of that produced by the forests of the whole British Indian Empire.

The reader may ask whether too much stress has not been laid upon the production of surplus revenue from the forests. The value to the nation of well-managed public forests consists less in the annual surplus revenue which they give than in the accumulated capital value which they represent, the supply of timber and other produce which they yield, and in the protection which they afford to agricultural and other interests. The real advantages of good forest management, however, are not yet recognised everywhere. In England, at least, and probably also in the United States, most people will be disposed to judge the management of forests by the surplus revenue they yield.

A few practical points I should like to recapitulate, and particularly to submit them, to those who may in the United States have to undertake the management of forests similarly constituted :—

(1) Collect data as soon as possible regarding the marketable species, growing stock, rate of growth, and their requirements.

(2) Cut sparingly, regulate your cuttings, according to circumstance, by area or by volume.

(3) Select the trees to be cut with due regard to the maintenance of the most valuable species.

(4) Increase the proportion of the more valuable kinds by planting, or by other means.

(5) Resist, if possible, the temptation to make a big boom at the outset, and form your plans so as to secure a sustained, and, if possible, a steadily increasing yield from the forests.

(6) If the question has to be decided which areas should be selected to be demarcated as reserved or state forests it is best, at the outset, to make these areas as large as possible. Hereafter, when the yield of these areas is known, it will be easy to give up such portions as may be less valuable for the extension of cultivation, and in order to provide local labour in the forests.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock :—

JANUARY 20.—"The Roller Boat of Mons. Bazin." By EMILE GAUTIER. SIR FREDERICK BRAMWELL, Bart., D.C.L., F.R.S., will preside.

JANUARY 27.—"Voice Production." By WILLIAM NICHOLL. Dr. C. HUBERT PARRY, Director of the Royal College of Music, will preside.

FEBRUARY 3.—"The Recommendations of the Recess Committee for the Development of Ireland's Industrial Resources." By the RIGHT HON. HORACE PLUNKETT, M.P. (Chairman of the Recess Committee).

FEBRUARY 10.—"The Chemistry of Tea." By DAVID CROLE.

FEBRUARY 17.—"Light Railways." By EVERARD R. CALTHROP. The ATTORNEY - GENERAL, G.C.M.G., M.P., will preside.

FEBRUARY 24.—"The Prevention of Fires due to the Leakage of Electricity." By FREDERICK BATHURST.

MARCH 3.—"English Orchards."—By GEORGE GORDON.

MARCH 10.—

MARCH 17.—"English Music in 1837 : a Sixty Years' Retrospect." By J. SPENCER CURWEN.

MARCH 24.—

MARCH 31.—"Cycling—Historical and Practical." By GEORGE LACY HILLIER.

Papers for evenings, the dates of which cannot yet be announced :—

"Dairy Produce and Milk Supply." By M. J. DUNSTAN, M.A., F.R.S.E.

"The Transmission of Power by Alternating Electric Currents." By W. B. Esson, M.Inst.C.E.

"London Water Supply." By Percy F. Frankland, Ph.D., F.R.S.

"The Evolution of the Silver Question." By Moreton Frewen.

"Children's Sight." By R. Brudenell Carter, F.R.C.S.

INDIAN SECTION.

Thursday Evenings :—

January 28, at 4.30 p.m. — "The Moral Advance of the Peoples of India during the Reign of Queen Victoria." By William Lee-Warner, M.A., C.S.I., formerly British Resident in Mysore, and Chief Commissioner of Coorg. The Right Hon. the Lord Herschell, G.C.B., D.C.L., will preside.

February 11, at 4.30 p.m. "The Progress of Science Teaching in India." By Professor Jagadis Chundra Bose (of Calcutta), D.Sc.

March 11, at 4.30 p.m.—"Prevention of Famine in India." By Sir Charles Alfred Elliott, K.C.S.I. (Secretary to the Famine Commission of 1878, and late Lieutenant-Governor of Bengal). The Right Hon. Lord George Hamilton, M.P., Secretary of State for India, will preside.

March 25, at 8 p.m.—"The Cultivation and Manufacture of Rhea Fibre." By Thomas Barraclough. Sir William Henry Houldsworth, Bart., M.P., will preside.

April 8, at 4.30 p.m.—"A Visit to Russian Central Asia." By Michael Francis O'Dwyer, I.C.S. (Assistant Commissioner in the Punjab).

April 29, at 4.30 p.m.—"The Ethnology, Manners, and Customs of the People of Kafiristan." By Sir George Scott Robertson, K.C.S.I. (late British Agent at Chitral).

May 20, at 4.30 p.m.—"India and its Commerce." By Sir James Lyle Mackay, K.C.I.E. (late President of the Bengal Chamber of Commerce).

The meetings of March 11, April 8, April 29, and May 20 will be held at the Society of Arts; and those of January 28, February 11, and March 25 at the Imperial Institute.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock :—

February 2.—"The Progress of the British Colonial Empire during the past Sixty Years of Her Majesty's Reign." By the Rt. Hon. Sir Charles W. Dilke, Bart., M.P. The Earl of Jersey, G.C.M.G., in the chair.

February 16.—"The Progress of Canada during the past Sixty Years of Her Majesty's Reign." By Joseph G. Colmer, C.M.G. The Marquis of Lorne, K.T., in the chair.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock :—

January 26.—"The Artistic Treatment of Heraldry." By W. H. St. John Hope, M.A.

February 9.—"Lithography as a Mode of Artistic Expression." By George McCulloch.

March 2.—"Gesso." By Matthew Webb.

March 30.—"Lead-work." By W. R. Lethaby.

April 27.—"Delft Ware." By Dr. J. W. L. Glaisher, F.R.S.

May 11.—"A Half Century of Line Engraving, 1780-1830." By George Clulow.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

William Burton, F.C.S., "Material and Design in Pottery." Four Lectures.

LECTURE I.—JANUARY 18.

Simple Earthenwares.—Plasticity *the* characteristic property of clay—Its influence on the shapes of pottery vessels—On the methods of manufacture, by shaping, throwing, and pressing—On the methods of decoration, by modelling, carving, incising, inlaying, and painting—The use of natural clays entirely confined to simplest kinds of pottery—Primitive pottery of all periods—The so-called Samian ware of the Romans—Mediæval sgraffito—Inlaying, as in encaustic tiles—Early slip-decorated wares—Introduction of glazes—Addition of other mineral substances to the natural clays—Modifications produced in the clay by such additions, both before and after firing, leading to alterations in the processes of making and of decorating—The evolution of fine earthenwares, stonewares, and porcelains.

LECTURE II.—JANUARY 25.

Faïence and Fine Earthenwares.—The use of colouring matters other than naturally coloured clays leading to a widespread desire for a white ground on which to display such colours—How this problem has been solved in various countries and at different periods—Siliceous slip—Tin enamel—Clays white throughout their substance—Influence of these various devices on (*a*) the form, (*b*) the methods of fabrication, (*c*) the decoration; examples—Persian faïence, Italian majolica, Delft, English earthenware—Increasing refinement of material leading to mechanical perfection of manufacture, and to more elaborate, more naturalistic, and finally more mechanical decoration — Variations in style and method of decoration invariably preceded by alterations in material and method of its preparation—The mistake of treating fine earthenware as a kind of inferior porcelain, and its results.

C. F. Cross, F.C.S., "The Industrial Uses of Cellulose." Three Lectures.

February 15, 22, March 1.

PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., "Alloys." Four Lectures.
March 15, 22, 29, April 5.

LEWIS FOREMAN DAY, "Design in Lettering." Four Lectures.
May 3, 10, 17, 24.

HOWARD LECTURES.

Thursday Evenings, at Eight o'clock :—

PROF. JAMES A. EWING, M.A., F.R.S., "The Mechanical Production of Cold." Six Lectures.

JANUARY 28.—LECTURE I.—Thermodynamic principles in refrigeration—The reversed heat-engine or heat-pump—Efficiency depending on range of temperature—Use of entropy diagrams—Co-efficient performance in ideal cases—The refrigerating machine as a heater.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. William Burton, "Material and Design in Pottery." (Lecture I.)

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. W. J. Dibdin, "The Character of the London Water Supply."

Imperial Institute, South Kensington, S.W., 8½ p.m. Dr. J. L. W. Thudichum, "The Origin, Nature, and Manufacture of Wine."

British Architects, 9, Conduit-street, W., 8 p.m., Address to Students by the President; and some Critical Observations on the Students' Work.

Medical, 11, Chandos-street, W., 8½ p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Prof. Hull, "The Assouan Embankment."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. J. A. Gray, "Experiences at the Afghan Court."

TUESDAY, JAN. 19...Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. D. Walker, "Animal Electricity." (Lecture I.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, S.W. 8 p.m. 1. Discussion on Professor W. Ripper's paper, "Superheated-Steam Engine Trials." 2. Colonel J. Pennycuick, "The Diversion of the Periyar." 3. Mr. P. Roscoe Allen, "The Periyar Tunnel."

Statistical, in the Theatre of the United Service Institution, Whitehall, S.W., 5½ p.m. Mr. Thomas A. Welton, "Local Death-rates in England and Wales in the ten years, 1881-90."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 12, Hanover-square, W., 8 p.m. Mr. W. Gamble, "The History of the Half-Tone."

Self-Propelled Traffic Association, Colquitt-street, Liverpool, 8 p.m. Mr. W. Worby Beaumont, "Mechanical Haulage on Common Roads."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Lord Walsingham, "Revision of the West-Indian Microlepidoptera, with Description of New Species." 2. Mr. F. E. Beddard, "Some Points in the Anatomy of the Manatee lately living in the Society's Gardens." 3. Dr. G. Lindsay Johnson, "The Classification of Mammals from the Opthalmoscopic Appearance of the *Fundus oculi*."

WEDNESDAY, JAN. 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Emile Gautier, "The Roller Boat of Mons. Bazin."

Meteorological, 25, Great George-street, S.W., 7½ p.m. Ordinary Meeting. 8 p.m. Annual General Meeting. Address by the President (Mr. E. Mawley), "Shade Temperature."

Geological, Burlington-house, W., 8 p.m. 1. Mr. Aubrey Strahan, (i) "Glacial Phenomena of Palæozoic Age in the Varanger Fjord;" (ii) "Raised Beaches and Glacial Deposits of the Varanja Fjord." 2. Miss G. L. Elles, "The Sub-genera *Petalograptus* and *Cephalograptus*."

Microscopical, 20, Hanover-square, W., 8 p.m. Annual General Meeting. Address by the President.

Entomological, 11, Chandos-street, W., 7 p.m.

Mining and Metallurgy, Geological Museum, Jermyn-street, S.W., 8 p.m. 1. Mr. S. J. McCormick, "Notes on the Treatment of Refractory Low-Grade Ores at the Ouro Preto Gold Mine, Brazil." 2. Mr. A. Mervyn Smith, "Notes on Blasting with No. 1 Dynamite, Blasting Gelatine, and Ammonite, in Chota Nagpur, Bengal." 3. Mr. John Daw, "Notes on Underground Lighting by Electricity."

THURSDAY, JAN. 21...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. G. Elliott Smith, "The Origin of the *Corpus callosum*: a comparative study of the Hippocampal region of the Cerebrum of Marsupialia and certain Cheiroptera." 2. Dr. J. Gilchrist, "The Minute Structure of the Nervous System of the Mollusca."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. W. A. Shenstone, "Studies of the Properties of Highly Purified Substances. I. The Influence of Moisture on the Production of Ozone from Oxygen and on the Stability of Ozone. II. The behaviour of Chlorine, Bromine, and Iodine with Mercury. III The behaviour of Chlorine under the Influence of the Silent Discharge of Electricity and in Sunlight." 2. Messrs. A. R. Ling and T. L. Baker, "Action of Diastase on Starch"—Part III. 3. Messrs. Horace T. Brown, G. Harris Mims, and J. H. Millar, "The Solution Density and Cupric-reducing Power of Dextrose, Goulose, and Invert Sugar." 4. Mr. A. G. Perkin, "Derivatives of Maclurin"—Part II.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. H. J. Powell, "The Art and Craft of Glass Making."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. H. A. Miers, Some Secrets of Crystals." (Lecture I.)

Historical, 28, Jermyn-street, S.W., 8½ p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m.

FRIDAY, JAN. 22 ... Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. Dewar, "The Properties of Liquid Oxygen."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Mr. W. B. Croft, "An Exhibition of some simple Apparatus." 2. Mr. E. C. Baly, "The Passage of Electricity through Gases."

SATURDAY, JAN. 23...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Carl Armbruster, "Neglected Italian and French Composers." (Lecture I.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening, 18th instant, Mr. Wm. Burton, F.C.S., delivered the first lecture of his course on "Material and Design in Pottery."

The lectures will be printed in the *Journal* during the summer recess.

HOWARD LECTURES.

A course of six lectures on "The Mechanical Production of Cold," will be commenced on Thursday evening, 28th inst., by Professor James A. Ewing, M.A., F.R.S., and will be continued on the following five Thursday evenings.

Admission to these lectures is on the same conditions as to the Cantor lectures, each member having the right of admission for himself and a friend.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

Proceedings of the Society.

SIXTH ORDINARY MEETING.

Wednesday, Jan. 20, 1897; Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Black, Thomas W., Ealing-road, Brentford.
Bersey, Walter Charles, 39, Victoria-street, S.W.
Blitz, Rudolf, 74, Leadenhall-street, E.C.
Brown, Arthur George, 38, Victoria-buildings, Manchester.
Cook, Joseph, The Poplars, Codnor-park, Alfreton.
Cox, James A., 44, Old Compton-street, Soho, W.
Grant, Alexander, Maryhill, Inverness.
Hewitt, William, Penn-grove, Aylstone-hill, Hereford.
Jordon, William Leighton, 25, Jermyn-street, S.W.
Mansfield, Edwin Alfred, 2, Aldermanbury-buildings, E.C.
Medlicott, John Henry, Office of Chief Engineer of Irrigation, P.W.D., Hyderabad, Deccan, India.
Page, Stanley Hatch, 23, High-street, Maidstone, Kent.
Stinson, Henry Alfred, Belgrave lodge, Mackenzie-road, Beckenham.
Ward, James, Ivy-lane, Macclesfield.

The following candidates were balloted for, and duly elected members of the Society:—

Armstrong, James G. D., H.M. Office of Works, Tunbridge Wells.
Doggett, William Charles, 17, Holborn-viaduct, E.C.
Donkin, Harry Julyan, 55, Southwark-park-road, S.E.
Fraser, Claud, 187, Gloucester-terrace, Hyde-park, W.
Geoghegan, Henry Thomas, 16, Faraday-mansions, Queen's Club-gardens, West Kensington, W.
Hall, Joseph, Municipal-offices, Cheltenham.

The paper read was—

THE ROLLER BOAT OF MONS. BAZIN.

By Emile Gautier.

There was once a Doge of Venice who, through the vicissitudes of an unfortunate policy, was led to visit the palace of Versailles, where, much against his inclination, he paid court to the great King, Louis XIV. The poor Doge was perfectly dumbfounded and bewildered; but, with the astuteness of an Italian diplomatist, he took great care not to show it. However, one evening, while walking in the palace gardens in company with a few courtiers, one of them having asked him what in that palace, of which the fairy-like splendour dazzled the whole world, astonished him most, he replied by the following memorable words:—"What astonishes me most is, in truth, to find myself here!"

If a similar question were put to me this

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evening, I should, I think, reply as the Doge of Venice did at Versailles. What astonishes me most in London, in presence of the Society of Arts, is certainly to find myself in its midst. I have indeed no sort of quality, no sort of right to be here; nor, above all, to be addressing you. I am neither a savant nor an engineer; and I cannot lay claim to being the author of any great discovery or work. I am a plain journalist, whose only merit, if indeed it can be called one, is to have followed my instinct, and to have created for myself a more or less happy speciality in the popularising of scientific questions. Nevertheless, I am called upon to describe and to explain to gentlemen, many of whom are, I know, savants and engineers, a scientific work of an exceptionally original character, a work which, if the final success crowns the hopes of its promoters, will have a very important influence on the commerce of the world. From these remarks it will be understood that it is only a popular and general account which I propose to give you of this interesting invention, leaving its details to be explained by engineers and men of science.

I have to speak to you about the roller boat. What is this Roller Boat? Well, allow me to tell you in the first instance, the roller boat is no myth. It is not one of those chimeras of which there are so many in Utopia, for it exists in fact. Yes, the roller boat really does exist. I have seen it; I have touched it; I have gone on board, and I was present when it was launched a few months ago at Saint Denis. It is at the present moment at Rouen, where it is being completed and equipped for its final trials on the open sea. It will not be long, now, before it will cross the Channel and anchor in the Thames, just below London - bridge. Unlike all the other big and little vessels constructed before, the roller boat does not glide through the water. Supported on revolving wheels, it rolls on the surface of the waves as a carriage rolls on a highway. There is, however, this difference, which I beg you to remember, because it is of capital importance, and I shall refer to it later on: that, in the case of the carriage, all the motive-power is employed in pushing the whole of the vehicle forward; whereas, in the roller boat, only a portion of the motive-power is used for the screw propelling the vessel, the surplus being employed for the rotation of the wheels, which do not act as propellers.

Imagine a large rectangular platform, supported on the axles of three pair of immense lenticular-shaped wheels. That uncouth-looking machine, as high as a house, is the roller boat. The wheels are hollow, so that with all the load they bear they do not sink into the water more than to the extent of one-third of their diameter. For instance, the trial boat, now being equipped at Rouen, is provided with wheels of a diameter of 10 metres, or 32 ft. 10 in., the draught of which is 3 m. 33 cm., or 10 ft. 11$\frac{1}{3}$ in. Those sharp-profiled hollow wheels, each of which resembles the hull of a vessel, or two vessels superposed, constitute so many buoys supporting the superstructure. As for the engines, the cargo, the cabins for the crew and passengers, the coal-bunkers, &c., they are all placed on or under the platform. Summed up in a few words, such are the essential features and general outline of the construction of the roller boat.

It remains to be shown what are the conditions and laws of its working. It was only yesterday that the first roller boat was built, but its initial conception is very much older. Such a strangely new and considerable work could not be produced in a day, or improvised at once complete. It cost its inventor, M. Ernest Bazin, long researches and many a night-long study. M. Ernest Bazin, who bears a striking resemblance to the late Napoleon III., is an engineer, well known in France and abroad for the fecundity and originality of his ideas. Long before the construction of his roller boat attracted so much attention to his name, he had already made many extremely curious inventions, amongst which may be mentioned a submarine machine, that served for the attempts made to raise the Spanish galleons sunk in Vigo bay; a rotary pan for the washing of alluvial gold; hoisting apparatuses, cranes, dredgers, &c. But the roller boat will certainly be M. Bazin's great title to fame.

The first time I ever heard of the roller boat, which, at that moment—for want of the necessary capital—existed only in the imagination of the inventor, was some ten years ago, at Levallois-Perret, in a workshop transformed by M. Bazin into a museum, which, for the lovers of industrial and scientific curiosities, is in itself well worth a journey to France. I had gone there to witness some experiments with the very ingenious apparatus invented by M. Bazin to reveal the presence of carbonic-acid gas in the air. When those experiments were over, M. Bazin took me into a sort of shed adjoining his laboratory, where I found a large oblong tank full of water. This is what I saw there: M. Bazin took a hollow copper lenticular-shaped wheel, of which the thickness at the axis went on diminishing towards the sharp-edged periphery. That disk was provided with two hubs which rendered it possible to give it a rotary motion. Placed in the water, that lenticular-shaped wheel floated in a vertical position. M. Bazin commenced by pushing it forward on the surface of the water as he would have done with any other floating body. The disk advanced, gliding through the water like a boat, its sharp edge representing pretty exactly the bows; but, after having advanced a few feet, the forward movement slackened, and soon entirely ceased. M. Bazin then seized the disk once more by the hubs, and while pushing it forward in the water, gave it at the same time a quick rotary motion with his thumbs and forefingers. Instead of forcing its way through the water like the hull of a vessel or any other floating body, the rolling disk, so to say, cut through the liquid mass, thrusting it down vertically. To prove beyond contest that under these conditions the wheel rolls on the water without displacing its molecules otherwise than by driving them down under it, M. Bazin added the following demonstration: he took a few straws which he placed on the surface of the water at a short distance from one another; then, without turning his disk, he pushed it forward towards them. It natually drove them up together in front of it, and being paralysed by the friction, it stopped altogether. M. Bazin next took his disk and once more pushed it towards the straws, while at the same time imparting to it a quick rotary motion. This time the straws were not driven back against one another; they were submerged, and the disk passed over them as it would have done had they rested on the ground, and its progress was not impeded.

This experiment interested me deeply; yet, I confess, it was not without a certain amount of surprise, and I may say of scepticism, that I heard M. Bazin say to me by way of conclusion, in his apostle-like fanaticism: "What you have just witnessed is simply the principle of the navigation of the future!"

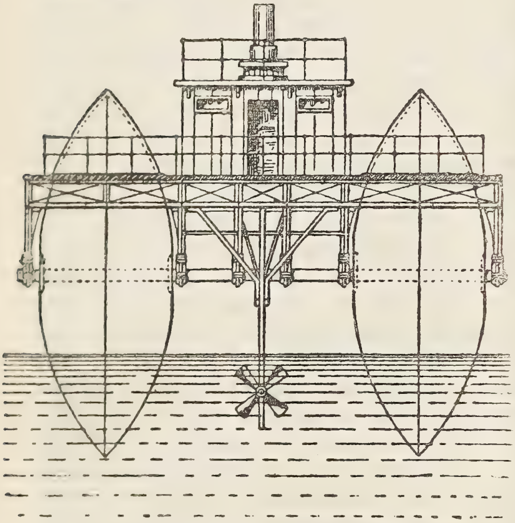
After all, M. Bazin appeared to be right to a certain extent; in any case, in what he had just shown me, there was something curious which it seemed to me might possibly be turned to account. Yet between that and a complete revolution in naval architecture and the art of navigation, the gap was as wide as that which, according to the old proverb exists but too often "twixt the cup and and the lip." I looked upon M. Bazin as a visionary and an idle dreamer. A few days afterwards, plunged in the midst of the turmoil of the battle of life, I had forgotten all about his schemes. But M. Bazin had not forgotten. He continued to meditate on them and to develop them.

Last year an unexpected piece of news reached me; M. Bazin had fallen in with a group of enterprising and courageous men, who, won over by his enthusiasm, had not hesitated to place at his disposal the necessary capital to construct a boat for the purpose of experiment and demonstration. As I said just now, it was that boat which I saw launched at St. Denis. Among the many thousands of spectators who witnessed the event with me were many English gentlemen, some of whom, I know are present here to-night. It is the same boat which M. Bazin proposes to send across the Channel very shortly by its own motive power.

The truth is, that this roller boat is built, and will really run according to the principle I saw demonstrated on a small scale, as I have described, that is to say, according to the principle that was applied in the case of the disks in the tank at Levallois-Perret. This principle consists essentially in the substitution for the gliding motion of the hull through the water, the rolling motion of the great wheels, in and on the water, in order to minimise friction, that is to say resistance, and thus to obtain the maximum amount of useful work. The ordinary existing ship, with its hull gliding through the water, represents the disk pushed forward without a rotary motion being imparted to it. As it is compelled to cut the water in front of it and to drive it back longitudinally, it would soon cease to move forward, did it not receive a fresh impulsion at every moment. Suppose, on the other hand, this same vessel supported by revolving buoys: it will possess all the advantages of the disk to which a rotary as well as forward motion is given, that is to say, that meeting with less resistance, it will advance more easily and quicker, with a lesser effort.

Allow me to suggest a comparison, which may not be strictly correct—for there are in the world no two facts or two leaves precisely similar in every respect. Nevertheless, if my comparison be not absolutely to the point, it has at least the merit of illustrating my idea, of making it clearer, more comprehensible, and more striking

Just try to push a hand-cart before you with the skid on. I do not say you will not be able to move it forward, especially if it is a light one, and if you happen to be a strong man; but you will have considerable trouble, because there will be a maximum co-efficient of friction. On the other hand, if the wheels of your cart revolve freely, you will have to exert less force; and, furthermore, if an independent mechanism acts at the same time on the axle and hastens the rotation of the wheels while you push behind, your effort, reduced to a minimum, will, so to say, disappear. Well, something of that kind takes place in the case of the roller boat.



Transverse Section of the Roller Boat.

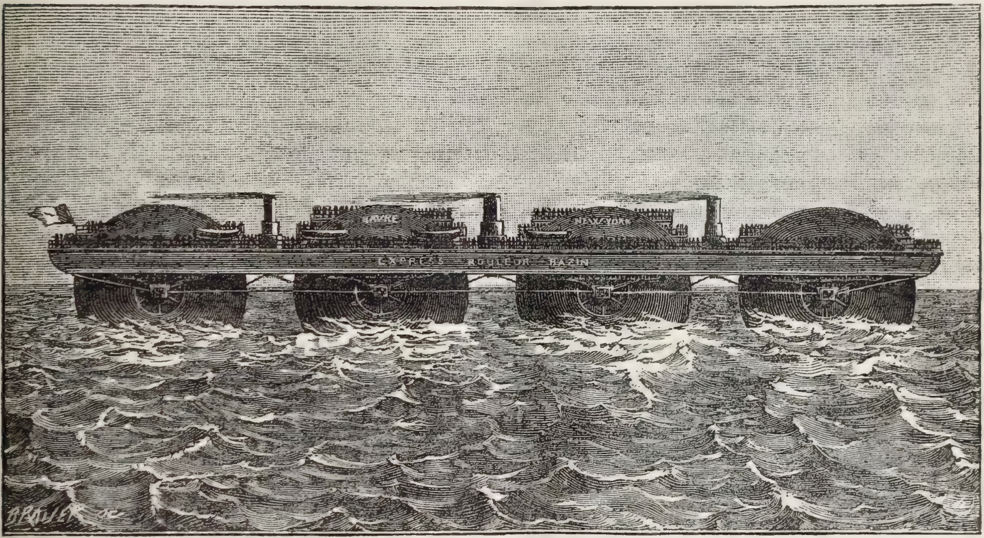
Let us suppose the boat in the water and its wheels at a standstill: the roller boat will stand in the same position as an ordinary ship, with this difference, that its hull is divided into several equal and similar portions, instead of having a hull in one piece. The resistance of the water will be the same as with an ordinary vessel having its midship frame equal to the sum of all those partial hulls, and it will require considerable force to move it forward. But if the wheels be set in motion, the same thing will happen as with the hand-cart. The resistance of the water remains the same, no doubt; but, as the hull represented by the lenticular-shaped wheels is animated with a rotary motion, the point of contact of the midship-frame with the water changes at every moment; and the effort, instead of being exercised longitudinally, is exercised partially downwards, vertically, so that the resistance is reduced in a considerable degree; the motive-power may consequently be diminished in a corresponding proportion. Yet it would not be sufficient to make the wheels revolve, for the roller boat does not behave like a locomotive, resting on solid rails, which moves directly the driving wheels are set in motion. The wheels of the roller boat would revolve without moving forward for want of sufficient adherence. This is what M. Bazin demonstrated in his experimental tank. When, handling his floating disk, he merely gave it a rotary motion, without, at the same time, imparting to it a forward push, the disk revolved on its axis perfectly well, but without changing place.

The roller boat can only progress in the water on condition that it is acted on simultaneously by two distinct forces, viz.:—Firstly, a force propelling it forward; and, secondly, a force causing its wheels to revolve, and thus reducing friction to its lowest amount. That is why a portion of the motive-power is used to work the screw, while the remainder is employed to drive the wheels. The great difficulty is to know how to harmonise the speed of the rotation of the wheels with the forward impetus given by the screw.

Then arose the question of establishing a true proportion, a mathematical ratio between the two forces. As a matter of course, this could not be done off-hand. At first, M. Bazin sought this in an empirical fashion, yet, strange to say, the formulæ he hit upon were afterwards confirmed entirely by the calculations of the mathematicians to whom the problem was submitted.

Let us note a particular point of the immersed portion of anyone of the wheels of the roller boat while in the act of revolving. This point possesses a tangential speed made up of two elements, viz., 1st, a vertical speed, which being perpendicular to the direction in which the vessel moves, offers no resistance, and causes but little friction; 2nd, a horizontal speed, parallel and combining with the forward motion of the vessel. Should this forward motion be less than the rotary speed of the wheel, in other words, if the rim of the wheel advances less rapidly than it revolves on its axis, the datum point will offer to the forward motion a resistance which will be equal to the difference between the two speeds. It will be a gliding point. On the other hand, if the forward motion is equal to the rotary speed the datum point will, so to speak, offer no resistance; it will be a rolling point.

Lastly, if the rotary speed of the wheels is superior to the horizontal speed imparted by the screw, those wheels, far from offering resistance, act, though in a very small measure, as propellers. It is, therefore, necessary to harmonise, as nearly as possible, the rotary and horizontal speeds, so as to reduce to a minimum the gliding which, in practice, can not be completely suppressed. Calculations and experiments have shown that this result would probably be obtained by making the rotary speed one half greater than the speed of translation. Under these conditions, the gliding friction is replaced by a rolling friction, and the forward motion of the vessel should be equal to about 60 per cent. of the developed circumference of the wheel. That is to say, with wheels measuring 22 metres (72 ft. 1¾ in.) in diameter, working at 24 revolutions per minute, a Transatlantic steamer could easily attain a speed of 60 kilometres (37 miles) an hour: Liverpool would thus be brought within three days and a half of New York. M. Bazin thinks that to obtain this result it will be necessary to distribute to the engines destined to work the wheels, about one-fourth of the motive-power serving to work the propelling apparatus, which may be either a screw or paddle-wheels.



The Roller Boat.

In any case the engines of the first roller boat, the *Ernest Bazin*, now being equipped at Rouen, will develop 750 horse-power, distributed thus: 550 horse-power for the propeller, and 200 horse-power for the three engines driving the three pair of wheels. With that power an ordinary gliding vessel of a similar tonnage would not steam more than 18 or 19 knots. It is expected the *Ernest Bazin* will attain at least double that speed.

This first roller boat, I repeat, is but an experimental vessel; nevertheless it has a displacement of 280 tons. Its measurements are:—Length, 40 metres (131 ft. 3 in.); beam, 11 m. 80 cm. (38 ft. 8$\frac{9}{10}$ in.) Its wheels have a thickness of 3 m. 60 cm. (11 ft. 9½ in.) at the hub, and they are coupled on shafts of 22 cm. (8½ in.) in diameter. It will probably not be long before you see it in English waters, as its first visit will be to England.

Gentlemen, this is about all that a non-scientific man can be allowed to say about the roller boat without the help of mathematics and diagrams. What will be its advantages, should it come up to the expectations of its inventor and of his friends? It is almost superfluous to insist on the point, for really they are too evident. Allow me, nevertheless, to point out, first of all, that the roller boat will give the means of realising a speed it would be utterly impossible to attain otherwise It is indeed a known fact that the resistance of the water is in ratio to the square of the speed of a vessel. It follows that the least increase in speed gives rise to enormous resistances which can only be overcome by a correspondingly large increase in the motive power. Now, it is not possible to go on indefinitely increasing the motive power, because the weight of the machinery and provision of coal would have to be increased in consequence. We have here a limit which no human power can overstep. A point is soon reached when the whole of the available space in a vessel is taken up by machinery and coals. Such is the case in certain torpedo boats, in which the crew can barely find sufficient space to move about, and which resemble an express train reduced to the engine and tender. It is tantamount to saying that a fast steamer can serve no purpose, inasmuch as it is no longer possible to provide accommodation for passengers and merchandise in it. And yet it is necessary to increase at any cost the speed of vessels. If, to that end it is not possible to increase their motive power beyond a certain limit, perhaps it may be possible, and even practical, to diminish the resistance of the water. That is precisely the solution sought by M. Bazin, and which he thinks he has obtained by the substitution of the rolling friction for the gliding friction.

Owing to the rotation of the wheels, a new factor is introduced which changes singularly the conditions of the problem. Henceforth, the resistance of the water will no longer increase in proportion with the square of the speed. The increasing resistance is naturally exerted on the midship-frame. Now, with revolving wheels replacing the hull, when once the speed of translation and the speed of rotation are mathematically harmonised, friction is reduced to a minimum.

Friction having thus become, so to say, a *quantité négligeable*, there appears to be no other limit to the increase of speed but the strength of the structure and the power of the engines. Hence all the consequences may be taken in at a glance. Speed, for speed's sake alone, has already many precious advantages, both for peaceful pursuits and the purposes of war, but the secondary advantages of speed are no less appreciable. Among such secondary advantages it is well to mention the diminution of crowding, and the consequent increase of available space on board.

Indeed, setting aside the fact that engines and boilers of 750 horse-power require less space than engines and boilers representing 4,000 or 5,000 horse-power, it must be remembered that they will also consume correspondingly less coal. M. Parrot, an eminent French professor, estimates at 3,000 kilogrammes (nearly 3 tons) per hour the saving in coal to be realised on that head by the adoption of the rolling principle in the *Ernest Bazin*. This is equivalent to saying that, supposing this vessel to be coaled for a run of 20 hours, say for a voyage of at least 1,000 kilometres (about 622 miles), the difference in the consumption of coal provides the displacement for 60 tons of freight.

It stands to reason that travellers will profit by the increased available space, as well as merchandise. If engines and cargo are located below and within the thickness of the platform, the cabins and saloons for the passengers and crew will be placed upon it. Existence there in the open air and sunlight, on a sort of floating esplanade, could no longer be compared with the troglodyte-like life which a passenger always has, to a certain extent, to lead in the dark bowels of a steamer, resembling at one and the same time a prison and a coffin. A voyage across the Atlantic on board a roller boat will, therefore, not only be faster and cheaper, but much more agreeable.

Of course many people have raised objections, and the successful launching of the *Ernest Bazin* has not been sufficient to close the mouths of the pessimists and systematic detractors of a work which, were it only for its boldness and originality, would appear to deserve universal sympathy and the unanimous encouragement of all friends of progress.

At the present time it is no longer possible to maintain, as some people obstinately did during the period of construction, that the roller boat would not even float, for it does float. But others persist in predicting that it will not prove seaworthy. With regard to that important point, theorists are divided into two camps. I have heard some distinguished mathematicians demonstrate by means of abstruse formulæ and equally correct calculations that the roller boat will behave admirably at sea; whereas other no less distinguished mathematicians show, on the contrary, by equally abstruse and equally correct calculations, that it must capsize in an only moderately rough sea, or on encountering anything like a heavy ground swell.

Experience, that sovereign arbiter on sea as on land in matters of scientific and industrial innovations, can alone settle this platonic and premature controversy; decide who is wrong and who is right, and conciliate, by the evidence of facts, conjectures apparently irreconcilable. Indeed, the roller boat, working under unprecedented conditions, presenting nothing on which comparison can be based, the problem of its future must contain a certain number of undetermined factors, to which theoretical rules cannot apply. Besides, so long as theory has not been verified by practice, it is always more or less unreliable.

Indeed, the people who, standing up in front of a blackboard with a piece of chalk in their hand, deny before any practical experiment the stability and seaworthiness of the roller boat, remind me of those other mathematicians who for years and years maintained that a cat, dropped with its back downwards from a height in the air, could not turn, so as to fall upon its feet, without the help of some extraneous force. The particular axiom was even regarded as a law, until the day when instantaneous photography made it perfectly clear that it was in flat contradiction to the real facts. Let us hope it will be the same with the roller boat.

I have, of course, neither the time nor the inclination, nor the necessary qualities to discuss the intrinsic merits of the theoretical objections raised by the mathematicians who act as prophets of evil towards the roller boat, but I may, perhaps, be permitted to mention certain suppositions, calculated to lead to the belief that those birds of evil omen are probably wrong.

I will not speak of the experiments made by M. Bazin in a big tank with a model 5 metres (16 ft. 5 in.) long, against which he drove artificially created waves, without in any way disturbing its floating qualities. Those experiments were carried out under conditions really too far removed from the nautical reality for any serious conclusions to be drawn from them. But there is something else. Look at the roller boat. It is positively a raft, supported by three pair of buoys: that is to say, it constitutes a naval structure, which may be considered as the ideal of stability. I may add that its breadth, which is considerable, can, without inconvenience, be increased, and the division of its hull into separate and independent hulls animated with a gyroscopic motion, ought, it would seem, to place it in a position to withstand with greater ease and safety both a swell and a rough sea. Its sustaining basis being very wide, one is justified in believing that it could only capsise on attaining an angle of inclination which no wave could possibly give it; and as there are in its sides large open spaces allowing the water to pass freely between the tapering surfaces of the wheels, it would seem that the shock of the waves ought to exert itself with less violence and abruptness than against the solid, vertical, and unbroken sides of an ordinary vessel.

Moreover, the roller boat is built in such a way as to be unsinkable. Not only can the wheels—which are autonomous and separate, and themselves divided into water-tight compartments—act for and support each other in case of one or more of them being damaged; but should one or more of those revolving hulls be injured in the course of the voyage, there would be no need to wait until a port is reached to pump out the water and repair the breach. All that would be required would be to give the wheel a slight turn to bring the hole above the surface of the water. It would then stand in the same position as a cask floating with the bung-hole upwards; and to effect the repairs would be easy. However, I admit these are only conjectures. But, by the side of these conjectures there are facts, the eloquence of which, though only indirectly applicable, is none the less of good omen.

All sailors who have visited Polynesia can vouch for the fact that the double canoes used by the natives of Samoa in their war expeditions, behave admirably at sea. Now, saving that their hulls glide and do not roll—which constitutes an inferiority, as rolling hulls should have the stability of a gyroscope—these double canoes have a singular resemblance to the roller boat. Indeed, they are made up of two large parallel canoes, some few metres apart, and joined by a platform on which the crew stand. Once more I say that these wretched boats, held together anyhow by means of cocoa-nut fibre ropes, have a perfect stability, and navigate perfectly on the high seas. Why should it not be, *a fortiori*, the same with a solid, strong boat, built with first-class materials by engineers thoroughly conversant with their profession?

But there is something better still. M. Bazin has built a nautical velocipede, on the same principle as his roller boat. The wheels are of course lenticular-shaped revolving buoys. Experiments made with it on the lake at Vincennes, near Paris, proved a most extraordinary success. They demonstrated the almost indestructible stability of the system, and at the same time the soundness of the principle on which M. Bazin hopes, not without some legitimate pride, to base the navigation of the future. And yet in the case of a velocipede, the centre of gravity is raised considerably as soon as the rider has taken his seat, and one would suppose that the balance ought to be particularly unstable and a fall correspondingly easy. Experience shows that such is not the case. The roller boat, acting under less unfavourable conditions, could not logically give less satisfactory results. Besides, perhaps M. Bazin's nautical velocipede, which gives promise of becoming one of the coming favourite instruments of sport, will be brought to England shortly to confirm the correctness of my statements.

Gentlemen, I have finished; not that my subject is exhausted—it could provide text for a number of volumes—but because I fear to exhaust your patience which I have already put to a severe trial. I may nevertheless be permitted to make one more remark. I am well aware no one is a prophet in his own country, and I do not aspire to the honour of being a prophet even here in a foreign land; but amidst a people, whose enormons mercantile fleets testify to the inexhaustible energy and enterprise of the Great British nation in every part of the globe, I may express the conviction that practical men will not fail to examine closely an invention which, according to its author, realises a large saving of both time and money. Doubtless, the great shipowners may at first be unwilling to admit that any new-fangled vessel can be superior to the magnificent floating palaces which they possess; but, if they discover—as I believe they will—that the roller system procures them not only a great economy of coal, but also accelerated speed, it seems to me they will not hesitate long to profit by those advantages. It must be remembered that the advantages of the roller system will very soon have been proved and demonstrated; and when that proof and that demonstration have been given, the transformation of the means of navigation may be operated more rapidly than many people imagine. Now-a-days the world wags quicker than it used to do. Who, a few years ago, could have guessed that the streets of all the great capitals of Europe, as well as the suburban and country roads, would in 1897 be, so to say, teeming with cycles? With that example before us, would it be rash to affirm that very soon the rivers and lakes of Europe and America will be teeming with nautical cycles and roller boats, even if it takes a little longer to revolutionse the means of ocean navigation.

It remains for me to thank you once more for the courteous affability with which you have received me, and particularly for the indulgent forbearance you have shown in listening to me. This does not astonish me because I have not only heard much of British hospitality but have already previously received it. Allow me, however, before taking leave of you, to tender you the expression of my gratitnde, both in my own name and that of my Fatherland. It is an exceedingly pleasant duty for me, representing as I do a newspaper which has the reputation of personifying better than any other the spirit of the French nation, to be able to seize such an opportunity as the present to salute and thank England, at the very moment when the prejudice and misunderstandings which, to the detriment of civilisation, have so long kept France and England apart, are disappearing daily, like the confused memory of a bad dream.

DISCUSSION.

M. GAUTIER, having been invited by the Chairman to add anything he liked in his own language, said, speaking in French, that he was very glad of the opportunity of tendering his thanks for the hearty and sympathetic reception he had met with in England, and for the honour done him by Sir Frederick Bramwell in taking the chair. He never regretted so much before that instead of spending so much time on Latin and Greek he had not made himself familiar with English. He had been profoundly touched by the kindness which had been showered upon him, but he took it as a compliment, not to himself, an unknown traveller, but to his country, and as a sign of a growing sympathy between two great nations.

Mr. H. GRAHAM HARRIS said that although present at the launch of the roller boat he did not think he could add anything of importance to the paper. He believed in Artemus Ward's advice, never to prophecy unless you knew, and as he did not know, and in a few weeks they would all know something about the performances of this new vessel, he preferred to wait. There was, however, one point, which he mentioned when the vessel was launched, which he thought would prove a difficulty in this case, as it had in the case of Captain Dicey's boat and the twin boat, the *Calais-Douvres*, where there were two hulls supporting a platform at some distance above the water level. The great difficulty was to construct them in that way without rendering the weight excessive, the platform having enormous strains upon it in a rough sea. A great deal of experience had been gained in the cases he had referred to, which might have been utilised by M. Bazin, and possibly the difficulty might prove to have been over-estimated, but it was a point of some practical importance.

Mr. J. I. THORNYCROFT, F.R.S., said he also would rather not prophecy, but he thought the paper bore out the statement which had often been made that inventors were very courageous, if not something more. Several points had struck him, one of which had been touched upon by Mr. Harris, but he would first desire to thank their neighbours across the Channel for what they had done, for any improvement in naval architecture which could be introduced would be most heartily welcomed, and all engineers must feel grateful to Mr. Bazin for the experiment he had undertaken. He could not help seeing, however, that he had many difficulties to contend with, especially when he came to increase the size of his structure. As you increased the size you could not find material that increased in strength, in proportion to the stresses which came upon it. A vessel built to cross the Atlantic must be of such a size that enormous strains would be set up between one part of the structure and another. Again, in an ordinary vessel the whole volume of the ship was available for useful purposes. This vessel was necessarily built exceedingly light, because it would be seen from the photographs that of the volume of the lenticular-shaped bodies, which formed six different hulls, not one-half would be available for displacement, all the rest being more or less useless; for he did not understand that it was proposed to utilise the interior of the rollers. The useful part was external to the six ships which carried the structure, and therefore, to make the thing a success, the economy of power to maintain speed must be exceedingly great. The figures given were rather meagre, and he should have thought that, even from an experimental vessel 16 feet in length, more data could have been given. The late Mr. Froude, who made many experiments on this subject, told him that there was a great difference in the wave-making resistance in a vessel depending on the surface friction; and the only hope of success he could see for this vessel was in the fact that, by reducing the surface friction, the wave-producing force was also greatly diminished. The form of a vessel consisting of six small ships, as this was really, was not favourable to rapid progress, and he ventured to suggest that the reduction in resistance could scarcely be so large as Mons. Bazin calculated upon. He proposed to drive a vessel of about the same displacement as a modern torpedo boat destroyer, with even greater speed, which seemed hardly probable, though he would not prophecy that it could not be done. But the amount of material necessary to build such a vessel to carry the same freight as an ordinary ocean steamer would be greatly increased, partly owing to so much of it not being available for useful purposes, and partly to the fact that it would be subject to stresses which an ordinary ship was not subject to.

Mr. Wolff said he had looked at the photographs and diagrams, and he could understand that if this vessel were only for a water velocipede, on a somewhat large scale, there might be sufficient displacement to make it a success; but if he understood the paper aright, it was intended to use this construction for large ocean steamers, and there he thought the difficulties would come in. He had had as much experience as most people in that direction, and he could not see how anything like the necessary displacement could be obtained to support, not only the platform, which would require to be very heavy, but the superstructure, the passengers, the engines, and, above all, the coals. He understood the last speaker to express a doubt whether it could be made strong enough to compete with a structure like an ordinary torpedo boat, which was not intended to cross the Atlantic or to stand very rough weather; and when the inventor talked of superseding the present ocean steamers, the difficulties were greatly increased. He thought they ought to have had more detailed figures as to the displacement effected, and the tonnage the vessel would have to carry.

The Chairman said the total displacement of the boat now launched was given at about 280 tons.

Mr. Wolff said 200 tons of coal alone would not go very far. There were not sufficient data given to form any opinion as to the probability of success. Whilst he was of opinion that it might do for small boats, for lakes or fine weather, he was rather inclined to prophecy that it would not be successful in the form of an Atlantic steamer.

Mr. S. S. Bromhead asked if any information could be given how the vessel was to be steered; so far as he could see from the drawings and description it would be very much at the mercy of the winds and waves in rough weather. The rollers or discs appeared to be perfectly smooth, and he should like to know if any experiments had been made in the direction of attaching floats to them, or ribs, which would act as paddles, and which might be made to feather, so as to avoid any reaction as they rose from the water.

Colonel Allan Cunningham said this paper came at a very opportune moment, shortly before the vessel herself was expected to arrive. It was quite a new mechanical departure, and of great interest, being an attempt to introduce rolling friction where a body was moving through the water, with some hope of the same success as had been attained on land, when rolling friction was substituted for sliding. Those hopes depended on M. Bazin's experiments, and of the interpretation of them. He should like to know if M. Gautier could say whether any similar boat or model had been actually propelled in still water or rough water, and if so, whether any practical advantage had been found in a reduction of the power required.

The Chairman remarked that the reader of the paper referred to a model 16 feet long tried in a tank, with artificial waves.

Colonel Cunningham said he understood that experiment only had relation to the waves, not to the power required for propulsion. He should like to know whether any attempt had yet been made to propel this new vessel. There were one or two points in which it differed extremely from anything yet seen. In the first place, nearly the whole mass was out of the water: in almost all other vessels, a very large proportion was below the water; racing yachts were almost entirely below, all but the sails. In large steamers, there would be about 30 feet below water, and the freeboard very much less. There the freeboard was much in excess of the submerged portion; and one was inclined to ask what the leeway would be? The only prevention to leeway was in immersion, and when that was insufficient a centre-board was used to create it. There was another point, as to the strength of the structure as a whole. Judging from the photographs, it seemed full of elements of weakness. An ordinary vessel was one cellular structure of immense strength, but this was a number of small structures, held together by girders, and he feared the effect of the winds and waves upon it would be something extraordinary. To show that great speed might be attained on a lake or canal was not sufficient to recommend an ocean-going steamer. The large drums seemed very much like the very large paddleboxes, which had never been made strong enough to stand the shock of the waves, and in fact been given up partly for that reason.

Mr. W. Leckie Robinson asked if any data could be given as to the distribution of the engines. He presumed they were to be on the platform, which was a considerable height above the water, and he should like to know how the power was conveyed from them to the screw and to the discs. If the inventor were going to propel a vessel at 38 or 39 knots an hour, with 750 horse-power, all those who had had any experience of torpedo boats or destroyers, would recognise that he had a difficult problem before him. So far as still-water navigation was concerned no doubt M. Bazin would have a large field, but he would prefer not to be on board such a vessel when encountering the waves of the Atlantic. He did not quite understand how the rollers were attached to the framework, but if one of them broke loose it would be rather awkward for the rest of the boat. No doubt these were mechanical details which might be got over, and some new metal might be invented which would smooth the way, but he had his doubts about it.

M. Hermite said he coald not add anything to the information given in the paper, except to say that he had been on the boat, that she was about to start on her trial trip, and would probably be over here in about six weeks. Each pair of drums was worked by a separate engine, and there was a special engine for the screw.

Mr. Simmonds said a great many of the questions which had been asked would be answered, and he thought answered satisfactorily, by reference to the specification of the English patent, which could be obtained for 8d. It was in 1892.

Prof. Le Neve Foster, F.R.S., said a great deal of information was given in the *Strand Magazine*, which can be got for 5d. or even 4½d. The steering, he gathered from that account, was said to be done by hydraulic power.

Mr. Shaw asked what was the speed of the water velocipede?

M. Gautier (replying in French) said he could not be expected to answer all the questions which had been put, or to contend in argument with a gentleman like Mr. Thornycroft, whose reputation in connection with naval architecture was world-wide. As he had said already, he was neither a *savant* nor an engineer, and he could only deal with the matter very generally. Mr. Thornycroft's objection related to the power of the structure to withstand the forces brought to bear upon it, and that was a question for metallurgists and engineers, and he ventured to hope that they would be able to solve the problem. The essence of the invention consisted in the application of the principle of rolling, instead of sliding friction. With regard to the question of stability and displacement, it had been decided to immerse the rollers about one-third of their diameter, because it had been calculated that that gave the most favourable conditions for carrying out the rolling motion; but if it were found necessary, for other reasons, a greater amount of immersion might be adopted. Deeper immersion would, of course, give greater stability, or that might be attained by means of ballast, water, or other. With regard to the steering, the boat now at Rouen had an ordinary rudder, but M. Bazin intended to introduce, as his normal method of steering a hydraulic system, fluid pressing against fluid, by which he anticipated the utmost nicety of movement would be attained. The question had been asked why the wheels were not furnished with paddles. Now this was not the first roller-boat—others had preceded it, in which the rollers were not lenticular but cylindrical, and they had floats or paddles attached to them for the purpose of propelling the vessel, but that principle was entirely different from M. Bazin's. This primary idea was to diminish friction as much as possible, and the use of paddles instead of diminishing friction would increase it. Some of the questions which had been suggested, as for instance that of stability, could not be definitely answered until further experience had been gained. This new boat would work under conditions so different from any which had as yet been experienced, that it was impossible to speak positively until the experiment had been actually made. There were so many new and unknown factors introduced, that practical experiment alone could decide how she would behave; but he might say that even if at first she were not entirely successful, there was no need for discouragement. M. Bazin intended to experiment under every possible condition, and thoroughly to test every problem so as to be able to make improvements in detail, and correct any defects which might make themselves apparent. Possibly the first experiments might show not that the principle was unsound, but that the constructive details were imperfect. Of course, stability would have to be tested under all conditions, and, fortunately or unfortunately, favourable conditions did not very often occur on the passage from France to England. He could not say anything definite as to the speed of the water velocipede, his attention not having been directed to that point, but simply to that of stability. So far, the trial was perfectly satisfactory, notwithstanding the elevated position of the rider. He might add that he had lately received a letter from a friend of his, a telegraph engineer at Marseilles, recounting his experiences some years ago with a *vélocipède nautique*. That was actuated by floats or paddles, and was therefore quite different from M. Bazin's roller boat, but on the question of stability it was perfectly comparable. His account was that he went out in a rough sea to superintend the laying of a submarine cable, and returned safely to shore, his stability not having been for one instant compromised. With the roller boat there would be the additional stability produced by the gyroscopic action of the disks. He must be pardoned if he had not answered all questions fully and distinctly, not only on account of his want of technical knowledge, but also from his want of familiarity with the language; but he had endeavoured to deal with them generally, and he could only repeat that experience alone would enable them to be thoroughly disposed of.

The CHAIRMAN, in proposing a cordial vote of thanks to M. Gautier, said the question of getting rid of skin friction was one which had excited the attention of naval architects for a long time. He might mention an attempt made in that direction in New York as long ago as 1853, in which one of the ferry boats crossing the Hudson, having practically a flat bottom, was provided with five shallow keels, forming four separate compartments, which extended from about one-fourth the length of the vessel forward, right to the stern. Into each of these four shallow channels air was forced by a pump, so as to form a stratum of air between the skin of the ship and the surface of the water, and thereby diminish friction. He saw that boat under weigh several times, and there was a curious soda-water effect at the stern, which—the vessel being a paddle-steamer, and having, therefore, no screw to make a wash—excited some surprise, until it was explained. He found, on inquiry, that, as well as could be ascertained, there was an advantage in introducing the air, which caused less power to be necessary for propulsion; but what was saved in that way was absorbed in working the air pump. The plan now brought forward would very shortly be tried, and their thanks were due to M. Gautier for bringing it before the Society at the present moment. M. Gautier did not come forward as a *savant* or engineer, but all who had heard the paper would agree that he certainly had the faculty of presenting a scientific novelty in an intelligible light. Having frankly stated his limitations it was perhaps hardly fair that questions of mechanical detail should have been addressed to him. They would all await with great interest the result of the trial which was so soon to take place. It might turn out that as far as extra speed for the same power was concerned, there was a beneficial result, but it always struck him (the chairman) that there was one radical defect in this system which had been referred to by Mr. Thornycroft. Regarding one of the discs on edge, assuming it to be immersed one-third of the diameter, and drawing a line through the axle, there was then, as regards the lower portion, a fair representation of an ordinary boat with a good amount of free board, and a fair draught of water. Such a boat would possess a certain power of flotation, and would need a certain amount of material for its construction, but where discs were employed, it was obvious that there was an equal weight of material above the axle, which, being all in the air, added nothing whatever to the power of flotation. It seemed to him, therefore, that the question of the excessive weight of material for the amount of flotation to be obtained would render the principle very difficult of application in the case of a large trans-Atlantic steamer. It might be that the diminution of resistance would be so enormous that the saving of weight in engines, boilers, and coal would compensate for the extra weight of the hull, but this seemed hardly likely. There was another point about the roller-boat that he must confess he did not understand, and that was the need for driving by engine power, the discs involving the consideration as to the rate at which these should be driven. He would have imagined that the mere friction of the water would have been sufficient to make the discs rotate, and would have done so at the speed appropriately representing the mean of the various discordant elements of friction in bodies having the differing diameters and forms of the immersed portions of these discs. The resistance to revolution would clearly be nothing but that of their axles in their bearings, and should, as it appeared to him, be readily overcome by the friction of the water on the skin of the discs. Whatever might be the result of the trials, he was quite sure the meeting would appreciate the enterprise of those who had been bold enough to embark capital in the undertaking, and thus enable the labour of years which the inventor had devoted to this subject to bear fruit. They were all anxious to know the result, and in any event they must give their hearty thanks to M. Gautier for his charming paper.

The vote of thanks was carried unanimously, and the meeting adjourned.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

JANUARY 27.—"Voice Production." By WILLIAM NICHOLL. Dr. C. HUBERT PARRY, Director of the Royal College of Music, will preside.

INDIAN SECTION.

THURSDAY, JANUARY 28, at 4.30 p.m.—"The Moral Advance of the Peoples of India during the Reign of Queen Victoria." By WILLIAM LEE-WARNER, M.A., C.S.I. The LORD HERSCHELL, G.C.B., D.C.L., will preside.

⁂ This meeting will be held at the Imperial Institute.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock:—

JANUARY 26.—"The Artistic Treatment of Heraldry." By W. H. ST. JOHN HOPE, M.A.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

WILLIAM BURTON, F.C.S., "Material and Design in Pottery." Four Lectures.

LECTURE II.—JANUARY 25.

Faïence and Fine Earthenwares.—The use of colouring matters leading to a desire for a white ground. How this problem has been solved in various countries and at different periods—Siliceous slip—Tin enamel—Clays white throughout their substance—Influence of these various devices on (*a*) the form, (*b*) the methods of fabrication, (*c*) the decoration; examples—Persian faïence, Italian majolica, Delft, English earthenware—Increasing refinement of material leading to mechanical perfection of manufacture, and to more elaborate, more naturalistic, and finally more mechanical decoration — Variations in style and method of decoration invariably preceded by alterations in material and method of its preparation—The mistake of treating fine earthenware as a kind of inferior porcelain, and its results.

HOWARD LECTURES.

Thursday Evenings, at Eight o'clock:—

PROF. JAMES A. EWING, M.A., F.R.S., "The Mechanical Production of Cold." Six Lectures.

JANUARY 28.—LECTURE I.—Thermodynamic principles in refrigeration—The reversed heat-engine or heat-pump—Efficiency depending on range of temperature—Use of entropy diagrams—Co-efficient performance in ideal cases—The refrigerating machine as a heater.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. William Burton, "Material and Design in Pottery." (Lecture II.)

Scottish Society of Arts, Royal Observatory, Blackford-hill, Edinburgh, 8 p.m. 1. Mr. A. T. Macfarlane, "A New Life-saving Engineering Appliance." 2. Lieut. Abbott, "Ships' Davits in relation to Life Saving, with a proposed New Form of Davit. 3. Mr. W. Forgan, "A Chemical Dead-black Stain."

Imperial Institute, South Kensington, S.W., 8½ p.m. Prof. A. H. Church, "Some Food Grains of India."

Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned Discussion on Mr. H. Martin's paper, "The Future of the Surveyors' Institution."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Actuaries, Staples-inn-hall, Holborn, E.C., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Sir E. Purcell Taylor, "The Zamanap for Registering High Velocities."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. C. V. Boys, "Capillary Ripples."

TUESDAY, JAN. 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. W. H. Hope, "Artistic Treatment of Heraldry."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. D. Walker, "Animal Electricity." (Lecture II.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Photographic, 12, Hanover-square, W., 8 p.m. Mr. Ernest Marriage, "Architectural Photography." (Illustrated.)

Anthropological, 3, Hanover-square, W., 8½ p.m. Annual Meeting.

Colonial Institute, Northumberland-avenue, S.W., 4½ p.m. Charles Christian, "Cyprus and its Possibilities."

Horticultural, Drill Hall, James-street, Victoria-street, S.W., 1 p.m.

WEDNESDAY, JAN. 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. William Nicholl, "Voice Production."

Royal Society of Literature, 20, Hanover-square, W., 1 p.m.

British Astronomical, University College, Gower-street, W.C., 5 p.m.

THURSDAY, JAN. 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section, at the Imperial Institute.) Mr. William Lee-Warner, M.A., C.S.I., "The Moral Advance of the Peoples of India during the Reign of Queen Victoria."

8 p.m. (Howard Lectures.) Prof. James A. Ewing, "The Mechanical Production of Cold." (Lecture I.)

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Joseph Pennell, "The Golden Age of English Illustrations."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. H. Klein "Opera in England during the Reign of Queen Victoria."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. H. A. Miers, Some Secrets of Crystals." (Lecture II.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. F. T. Hollins, "Electrical Interlocking the Block, and Mechanical Signals on Railways."

Camera Club, Charing-cross-road, W.C., 8¼ p.m.

FRIDAY, JAN. 29... Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. Jagadis Chunder Bose, "The Polarisation of the Electric Ray."

Philological, University College, W.C., 8 p.m.

SATURDAY, JAN. 30...Royal Institution, Albemarle-street, W., 3 p.m. Mr. Carl Armbruster, "Neglected Italian and French Composers." (Lecture II.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Mr. William Burton, F.C.S., delivered the second lecture of his course on "Material and Design in Pottery," on Monday evening, 25th inst.

The lectures will be printed in the *Journal* during the summer recess.

APPLIED ART SECTION.

Tuesday evening, January 26, 1897; Lewis Foreman Day in the chair.

The paper read was "The Artistic Treatment of Heraldry," by W. H. St. John Hope, M.A.

The paper and report of the discussion will be published in a future number of the *Journal.*

Proceedings of the Society.

SEVENTH ORDINARY MEETING.

Wednesday, Jan. 27, 1897; C. Hubert Parry, D.C.L., M.A., Mus.Doc., Director of the Royal College of Music, in the chair.

The following candidates were proposed for election as members of the Society:—

Ellis, William Frederick Wood, Bombay, India.
Heimpel, J., Dindigul, Southern India.
Powell, James Crofts, Whitefriars Glass Works, 26, Tudor-street, E.C.
Sewell, John, 199, Victoria-street, S.W.
Tennant, Hon. Sir David, K.C.M.G., 112, Victoria-street, S.W.
Weaver, H. J., Guildhall, Gloucester.
Whittuck, Edward Arthur, M.A., B.C.L., 77, South Audley-street, W.

The following candidates were balloted for, and duly elected members of the Society:—

Chart, Robert Masters, The Limes, Mitcham, Surrey.
Gahagan, Ronald Hayes, 30, Nepean-sea-road, Malabar-hill, Bombay.
Head, Jeremiah, 47, Victoria-street, S.W.
Johnstone, Capt. James H. L'Estrange, R.E., The Hangingshaw, Selkirk, N.B.
Letts, Charles, 8, Bartlett's-buildings, Holborn-circus, E.C.
Marsden, James, Grosvenor-house, 18, Grosvenor-road, S.W.
Penn, William Cooper, 15, Victoria-street, S.W.
Rovsing, Capt. Christian, M.C., B.A., care of the Siamese Legation, 23, Ashburn-place, S.W.

The paper read was—

VOICE PRODUCTION.

By William Nicholl, A.R.A.M.

I can only hope, in the time at my disposal, to touch on a few of the many branches which belong to voice production; and it shall be my endeavour to treat the subject in such a manner as will prove of interest to the speaker as well as to the singer.

My experience, as a student, singer, and teacher, convinces me that the real art of voice production is yet in its infancy. The knowledge which enables a teacher accurately to diagnose all voices coming under his instruction is indeed rare, and it must remain so till those who teach have had practical experience, not only in the production of their pupils' voices, but in the production of their own voice. The violinist does not profess to teach the pianoforte or the pianist the violin. These, and many other branches of music, are taught by those who have made a special study of the subject. Nearly everyone, whether violinist, pianist, organist, or conductor, undertakes to teach the art of voice production. I would like it to be fully understood that, in my remarks on this subject, I am not advocating anyone's particular method. Personally, I have a strong objection to the word method, as applied to voice production, when it, as is frequently the case, implies that an individual possesses some secret of producing good tone which is his own particular discovery, and must therefore be as carefully guarded as if it had been patented. Voice production is no secret. It is the result of a natural use of natural means in a natural way. Voice production on the part of the teacher demands first a knowledge of how to produce good tone, and secondly, a knowledge of how to obtain the desired quality of tone. Every instrument must possess at least three essentials in the production of tone—(1) motive power, (2) tone-producing agent, and (3) the reinforcers of the intrinsic tone.

The violin, which I shall take as an example because it is more familiar to the majority than other instruments, possesses these three essentials in (1) the bow, (2) the strings, and (3) the violin itself. The bow we will liken to our breath, the strings to our vocal cords, and the violin to the resonators of our voice. Now the great difference between the violin and the voice is that in the violin we have the fixed resonators only, in the voice movable, in addition to fixed, resonators.

No doubt you have noticed that we can produce a variety of tones with the violin. The first efforts of the uninitiated are far from pleasant, even if made upon the finest "Strad" in the world. Why should it be so? Because the player is producing, from lack of knowledge and practice, a bad intrinsic tone. The violin as a resonator is reinforcing the tone created by the vibration of the string or strings by faulty bowing. As the bowing improves the tone improves, we therefore find one thing only necessary to master in tone production on the violin, because the resonators are fixtures.

The intrinsic tone of the voice is produced by the vibration of the vocal cords. The size and shape of the resonators determine, to some extent, the quality of the voice. The quality is more materially affected by the adjustable resonators.

Our first object in playing the violin is to master bowing; our first object in voice production is to master breathing. Manuel Garcia told me correct breathing formed 75 per cent. of the whole work of a singer.

Of the various methods of breathing, abdominal and costal are the best known. In abdominal breathing we have a decided increase in the region of the abdominal cavity, slight lateral expansion, no movement of the shoulders, and little or no expansion of the upper walls of the chest.

In emission of breath for tone we have the tendency to a downward pressure, especially towards the end of the breath; so much so in some cases that the voice suddenly collapses. This is not the result of shortness of breath, but of wrong application, and if we reverse the action we find that we are enabled to produce a bright tone without taking a fresh breath. This alone is a strong factor in favour of costal breathing.

In costal breathing we have a flattening of the abdomen, great lateral expansion of the ribs, and an increase of the whole thoracic cavity, from collar bone to diaphragm.

It has been demonstrated that apart from greater control we have greater capacity; I cannot, therefore, imagine why there should still be any doubt on the subject, except from the fact that we are all, more or less, loath to give up old habits. Another immense advantage in costal breathing is that through obtaining a greater quantity of air and greater compression, the tone is more strongly reinforced. It is almost needless to say that I advocate costal breathing, for both singers and speakers, and my reasons for so doing are based on the best of all reasons—practical work. I used abdominal breathing for the first eight years of my career, but when I adopted costal I obtained increased strength of all the abdominal muscles, greater capacity and control of breath, and in the voice, increased brightness.

Respiration consists of two acts, inspiration and expiration. The amount of breath we inspire is determined by the expansion of the thoracic walls.

Breath should be inspired through the nose, and never through the mouth. Dr. Greville MacDonald gives the following results, in a treatise on "The Respiratory Functions of the Nose," showing how the temperature is changed from the time it enters the nostrils until it passes through the pharynx just above the larynx. When inspired at 20° Fahr., the temperature rose to 82°; at 40° Fahr., it rose to 95°; at 53° Fahr., to 96°. When inspired at 112° Fahr., the temperature was reduced to 92°.

The temperature of the blood is 98.4°. Before the air reaches the vocal cords it must have virtually attained this heat. Cases of obstruction in the nose, and consequent deterioration of quality of voice, are common, and, in the majority of cases, due to faulty respiration. Many teachers are of opinion that breathing through the nose can only be indulged in when the voice is not being used. This is quite wrong, and either goes to prove the teacher's defective power of breathing freely through the nose, or his unbelief in the ability of others to carry out what he is incapable of carrying out himself.

Before leaving the subject of inspiration, I must say a word on the subject of corsets. It will be short, and to the point. No woman who wears them can breathe properly. The lateral expansion I have mentioned in costal breathing is a closed book to those who do. If women would only realise that in the "abdominal muscles" they have the finest corset ever made, which only require to be developed by exercise, they would never wear them again. Some of you who have seen native women in the East can vouch for their splendid figures. They have never known any dress which has destroyed the figure. I believe the present popularity among the fair sex of bicycling is doing more to bring about a healthy form of dress than all the doctor's warnings or teacher's lectures on the subject.

From inspiration I am naturally led to say something about expiration, and again I must remark that practical experience, both as a singer and teacher, are my sole reasons for advocating the use of certain methods.

With the object of arriving at a solution to the problem of breath control, Dr. Wyllie, in 1866, made numerous experiments upon the exsected larynx, by which he demonstrated that "there is within the larynx a double valve which is capable of controlling both the exit and entrance of the air." Drs. Cash and Lauder Brunton confirmed the experiments made by Dr. Wyllie, and recorded in an article on "The Valvular Action of the Larynx." I will quote from this article :—

> "Our own investigations completely confirm those of Dr. Wyllie. If the view, that the functions of the false cords or ventricular bands is to close the glottis during effort, and thus fix the thorax, is correct, we should expect them to be strongly developed in those animals whose habits render fixation likely to be serviceable; on the other hand, we should expect them to be absent in those animals in which fixation of the thorax would be of little or no service: and this seems to be actually the case."

The above points to the fact that all animals who have the power to lift, strike, or hug have the false cords fully developed, because, in order to get lifting power, force to strike, or to hug, the breath must be held in check; the thorax then forms the *point d'appui*, or point of resistance. Those animals who have no such power have no false cords.

It is conceded by throat specialists that the false cords do close when a breath is held in check; but so far, with a very few exceptions, they have been unable to say if these cords can be governed, so as to control breath. It must be remembered, however, that throat specialists make their observations under conditions which preclude the possibility of a pure tone being produced.

What further proof have we, apart from the observations of the medical men I have quoted, to show that the false cords will govern breath; and why should we want to prove they should? For the first step, in establishing this all-important principle, I will take that which appeals to the majority of teachers and singers, viz., the exercise which is known as the "shock of the glottis." I prefer to call it attack, as the word shock is apt to give the idea of force. The famous opera singer, Maurel, in his lecture, delivered some years ago at the Lyceum Theatre, laid great stress on the attack *(coup de glotte)* as an important factor in voice production. Let us analyse this attack.

"When the expiratory muscles are used as in expiration, and at the same time the escape of breath is prevented by the closure of the false vocal chords, the air in the lungs becomes compressed. . . . . When these cords are opened slowly, an unmusical sound is produced, and when they are opened suddenly a sharp, resonant explosive sound is produced." In releasing the air the sound of the letter "u," as in the word "utter," is heard. "The little explosion accompanying the sound of escaping breath we shall call the attack (usually called "shock") of the glottis. The force of the escaping breath which follows the attack should be varied by altering the aperture between the false cords until the student gains full control over them. . . . . We not only obtain breath control by this exercise, but we also learn to produce a perfect intrinsic tone, *i.e.*, a tone produced by the unimpeded vibrations of the vocal cords, a tone which is free, pure, rich, and sonorous." In the breathey falsetto voice the false vocal cords are nearly as wide open as in expiration, and the vibration of the vocal cords is confined to the thin edge. Here we have one force at work (the breath), and we find it an impossibility at first to change this voice into full voice without a break. This break would be called a change of register by those who believe in registers. The possibility of converting the breathey falsetto tone into pure voice without a break can only be achieved by the development of the false cords, and the ability to gradually close them from the full open position until the vocal cords begin to vibrate in an air of equal density."* Did we not possess false vocal cords we should, as Dr. George Cathcart said at the meeting of the Incorporated Society of Musicians at Scarborough, a few years ago, "not only cough like a cow but sing like a donkey."

I have mentioned the word "registers." That there are frequently breaks in a voice we must all concede, but that these breaks arise from natural causes or belong to such a perfect instrument as the human voice I utterly disbelieve. Teaching on the system of registers is the cause of much mischief. I am glad to see from correspondence and articles in some of our leading musical magazines, that not only are the false cords as a breath-controlling medium taking a healthy hold in teachers' minds, but that registers are slowly but surely being ignored in voice culture. It is quite enough to have to deal with faults which we find in a pupil, without adding a host of complications. When a singer has studied sufficiently to have good command of his voice there should be no undue effort of mind or body. The work should be as freely and as easily accomplished as the ordinary speaking voice. In such a case not only will the singer feel absolute freedom and ease, but the listener will be spared the pain of having to witness facial contortions, and the many other means the badly-taught artist employs in order to get his notes out. The compass of the voice will expand both up and down, and three to three and a half octaves will not be looked on as phenomenal, as it is now.

Taylor, in his "Sound and Music," says that "when a sounding body causes another body to emit sound we have an instance of a remarkable phenomenon, called resonance."

"The second body, in such a case, is called the sympathetic resonator. There are two kinds of such resonators of the voice, fixed and adjustable. To the first belong all the fixed bones situated above the abdominal cavity; to the second, the walls of the chest, the trachea, larynx, tongue, lower jaw, soft palate, lips, cheeks, and nostrils."* A perfect management of the voice depends on the knowledge of how to use the resonators. It is immaterial to the singer which he possesses, and, to quote the late Sir Morell Mackenzie, in his "Hygiene of the Vocal Organs;" the difference between artistic and inartistic production of the voice depends far more on the management of the resonators than on the adjustment of the vocal cords.

So far we have treated of breathing and the balance of breath and tone. Many artists can produce good tones in their vocal exercises which suffer considerably the moment they attempt to apply language to these tones. I shall, therefore, say something on the subject of balance of language and tone. It is the second great branch of a vocalist's work, and what applies to vocalists equally applies to speakers.

Melville Bell says the voice organs and the articulating organs are entirely separate and independent. That "the quality of clear cut articulation depends on the due separation of the functions of the vocalising and articulating organs. The vocal sound seems to be unbroken because the actions of the tongue and lips while interwoven with it do not interfere with it. All singers and all speakers may attain this bright excellence of articulation by forming consonants with the economic impulses of the pharynx instead of the wasteful explosion of breath from the chest. The element of audibility in oratory, as in singing, is the voice, but the voice carries with it to the remotest corners of church, hall, or theatre, the articulations of the mouth which, of themselves, would be inaudible over such an area. Let the fact be noted that this beautiful result, when most perfectly attained does not involve laborious effort, but, on the contrary, is accomplished with a minimum of labour and fatigue on the part of speaker and singer."

Now I will give you a few examples of what we hear when the conditions are not such as Melville Bell avers they ought to be. We hear the first line of our national anthem rendered "God save our gracious (s) queen." The chorus in the Messiah sing "For (r) unto us a child is born." In a very beautiful song, by the late Goring Thomas, we get "Time, gentle handed driver, his (s) piteous (s) team compels." And the tenor tells us he "calls life's (s) crew together," in Dibdin's immortal "Tom Bowling." Study Melville Bell, and you will find that it is possible to get rid of these difficulties to the great benefit of both language and tone.

Our linguistic faults are, as a rule, traceable to imitation at infancy. A boy who shows musical aptitude, if he takes up the piano or violin, commences his studies at the age of five to seven years. When he is 17 he has, if properly trained, mastered all the difficulties and avoided bad habits. The poor voice, however, has been allowed to go its own sweet way, and has year by year increased its load of faults, so that at 17 or 18 we have to deal with an instrument which has been wrongly used, and, in some cases, so badly treated that it is almost impossible to cure the disease. In such cases it is the rule to condemn the instrument, which might have turned out, if properly looked after, a priceless one. You may possess a "Strad," but it is easy to produce bad tones if you are ignorant as to how it should be played. In such a case we blame the player. In the majority of cases of bad voices we blame the voice. We ought to blame the user of the voice.

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* From "A Text-book on the Natural Use of the Voice," by George Thorp and W. Nicholl.

I would draw your attention to the Table of consonants and vowels, and I will go over them and give their true articulation. The three voice consonants, B, D, and G, I use as exercises for development of the mouth, pharynx, and trachea. B develops all three, D the two last, and G the last only.

In the breath consonants notice how the consonant, if produced by a puff of breath from the lungs, destroys the vowel, and how, if produced with the air in the mouth, is strong without injuring tone. Try and sing "show" with a clear tone on the "oh," separate "sh" from "ow" and you will see what I mean—"sh-ow"—giving "sh" its articulation and "ow" its tone. Now join the two, and see if you still preserve the tone you got on "ow" alone; if you do you have solved the problem of good articulation in breath consonants.

Now I contend that such work as this ought to be taught in our schools. Do you know a boy or girl who can articulate a consonant if you ask them? I do not. I find they do not even understand what you mean by articulation. As for adults, if they understand you it is a matter of time and patience to attain any degree of facility, simply because the organs employed have got stiff and rusty from want of use.

Flexibility of lips is rare among untrained voices and flexibility of the tip of the tongue still more so. We work with our throats and the base and root of our tongues.

Why should there be such a difference in tone quality when such conditions are present? Sound, like light and heat, travels in straight lines. It is commonly (in the case of the voice) supposed to roll out of the mouth. Well, it does not. We begin, we shall say, with one line of sound starting at the vocal cords. The condition of the throat above the vocal cords determines how few or how many lines and angles the sound takes before it leaves the lips. The two diagrams on the board will illustrate what I mean. In one you have a case in which the tone strikes soft substance many times before it comes to a bright resonator, therefore the whole tone would be a woolly one; the second gives a more equal balance of bright and soft resonators, and the tone therefore would be full, round, and sonorous. I will illustrate the action of the resonators with a tuning fork, first resonated on this book, secondly on the piano, and thirdly on the book placed on the piano. The first is a muffled tone, the second inclined to be hard, and the third has the combination of both, and gives a good round tone.

You will notice that the closer I make the contact of the book to the piano, the better the tone; in fact, we seem to hear a "crescendo," and without any more effort, so far as the intrinsic tone is concerned. So in our voice, the admixture of hard and soft resonators, under ordinary conditions, gives a round, agreeable tone.

Before I conclude I think it will interest you to hear something about the phonograph and the lessons it teaches us. I made experiments on both singing and speaking voice on one of Edisons's phonographs for two years. At first, I was under the impression that loud tones could not be recorded with satisfaction as to the result heard when the record was repeated; but I found that bad results were only due to force. If anything approaching a pure tone was made, however loud, a good record was the result. This applied to both the singing and speaking voice. In looking at the cylinder (which takes 100 lines of record in its circumference to the inch) it was very easy to tell if any word or tone had been forced. The particular part of the line with a forced word or tone, always showed a broader *scratch* than the other fine indentation which the needle had made. It was always a fine example of "how little we hear our voices as others hear them," to listen to the remarks made by the individual who made a record and then listened. The singer jeered at the idea of that being a bit like his voice; although, when he heard someone else make a record and then listened, he was amazed at the truthfulness of the instrument. The reciter not only failed to recognise his own voice, but did not believe that he dropped his voice at the end of sentences as the phonograph did. We most of us know how an untouched photograph not only tells the truth, but seems to exaggerate it. The phonograph seems to exaggerate to a still greater degree, but I think this is only due to the concentration which listening to its records necessitates. If we cultivate that much neglected "concentration" we find we hear many things we were unable to detect. How few take the trouble to cultivate it.

Time does not permit of my going any further into the subject I have had the honour of speaking to you about. I shall feel more than repaid if I have been the means of awakening an interest in the voice, and its possibilities to produce in all at least pleasing tones. I think it is the least understood of all instruments.

Familiarity breeds contempt. If we all possessed "violins" we would not appreciate the players, or their fine instruments so much, and we should all consider ourselves competent, as we do with the voice, to pose as judges of what is good or bad.

I have quoted freely in my paper from "A Text-book on the Natural Use of the Voice," by George Thorp and myself, and I cannot close without acknowledging my indebtedness to my friend for his help and good advice. It is our aim to awaken in the minds of our singers and speakers the possibilities of a higher development of the voice than has yet been attained by the great majority of artists.

DISCUSSION.

Mr. PAUL MAHLENDORFF said Mr. Nicholl started by asserting that breathing was the most important of all things for the singer; he, however, did not attach so much importance to it, for he could prove that it was only secondary in voice production. Every boy, almost, had made a whistle from a stick of willow; he made a hole near the top, and when he blew into it, the air striking against the edge of the hole, produced the sound. The breath, of course, was necessary, but the most important point was the position and proportions of the hole; if it were near the middle, there was a poor sound, half breath, and if at the lower end there would be no sound at all but of the air escaping. If, again, the material—the bark—were flabby, the sound was poor. Now the corresponding parts of the human organism were the vocal cords and their condition, and that depended on the elasticity of the brain mass which regulated them. It all depended on the peculiar tension in the brain mass, which might be entire or only partial, and on this tension it depended whether the voice was tenor or baritone. The next question was, whether it was possible to influence the position of this brain mass, so as to get the necessary rigidity for good voice production? It was possible, but it took him two years to find out how to do it. There was a certain bone just behind the frontal bone; it formed a cavity, which had the same relation to voice production which the governor had to a steam-engine, and regulated the vocal apparatus. It frequently happened with children that screaming, &c., caused the brain to press against the inner side of this resounding chamber, and partially close it, but, by proper training, it could be opened again, and this was the most important factor in voice production.

Mr. CHARLES LUNN said they were told that voice production was in its infancy. When he was a boy, teachers taught but little, but that little was true; now they taught much, but it was false. He suggested that those who wished to guard the public against pernicious teaching should endeavour to get a commission appointed, comprising the leading scientific men, to investigate the matter, and sweep away all fables and fancies which were capable of refutation, and establish a set of sound principles, which should be taught uniformly, though with differing degress of success, according to the abilities of the teacher. He had come to live in London for the purpose of trying to accomplish something of that sort. During a residence of 30 years in Birmingham, as a professional teacher, he had from time to time had many of his pupils come up to London to be finished. And they were; but no one ever heard them sing again. It was quite time for people to know that the use of the false vocal cords of which Mr. Nicholl had spoken, was discovered by Galen 1600 years ago. It was unearthed by Dr. Gordon Holmes, of Finsbury-square, to whom he owed the power of reproducing it before the public. They did not want a better authority on physiology than Galen, nor on physics than Sir Isaac Newton, and from them would be gathered what Mr. Nicholl had told them, that there were points of resistance and pressure, and unless those points were equally balanced the voice was not true. On one point he did not agree with Mr. Nicholl, whom he understood to say that, when a tone was properly produced it had the sound of *oo*; he maintained that the natural sound of the open mouth was *ah*, and it was purely a physical result. All the other vowel sounds were produced by an act of the will, and were therefore metaphysical. It was an axiom in science always to take the physical side of a question first, and then the metaphysical. Some said you could not have a uniform principle, and when he read a paper before the Society of Professional Musicians, Mr. Cummings said every voice had to be treated differently. He, and every one in the room had an immense deal in common, though beyond those uniformities there were certain peculiarities. The aspirate and the attack had been mentioned. He was not quite sure that he followed the paper correctly, for it seemed to him that Mr. Nicholl had, in speaking of the consonants of the voice, gone contrary to what he said in his book; but at any rate it came to this. All musicians were aware that it was a mark of culture when you could isolate one set of muscles and nerves from another set; and a still further step was made when you could make each set act independently, as the fingers and the two hands did in pianoforte playing. The duty of the voice trainer was to cut off the voice from the words, so that each was independent, and yet both acted together under the control of the will. Without that no one could be a good singer. The usual experience was that those with words had no voice, and those who had a good voice had no words. The old school, a century and a half ago, always employed vocalisation to smooth the voice and equalise it, just as all musical instrument makers endeavoured to get an equal, level tone throughout. Sol-fa was introduced by incompetent teachers who could not equalise the voice, and they brought it in to distract the pupil's attention from his own stagnation. Some years ago, Professor Graham Bell showed him the beginnings of a machine he was making to show the carrying power of the consonants, but unfortunately he heard no more of it, for he should much like to see something of the kind brought out, as he was sure that some consonants were more incisive, and travelled farther than others —for instance, the "s" as heard in congregational singing. Others were more diffusive. Many public speakers seemed to drop their "h's," when in fact they put them in; but they were not strong enough, and they would not carry. Sound was not projected like a stone thrown from the hand, but travelled like a vibration along a stretched rope. Many singers thought they had to sing *at* their hearers, whereas the louder you wanted the sound to be, the more you ought to keep it in.

Mr. GEORGE THORP said he was pleased to find that the action of the false vocal cords seemed to be recognised. Altough it was discovered by Galen so long ago, the honour of having re-discovered it was due to Mr. Lunn, so far as the voice was concerned. He might, however, add a word to what had been said on this important point, because the use of these cords did not seem to be quite fully understood. The vocal cords themselves were not sufficient to do the work of voice production, and at the same time to restrain the air by which the tone was re-inforced. If the vocal cords themselves had to resist the upward force of the breath from below they would vibrate upwards with a great deal of force, but in their return they would be checked by this upward force, and their action in the two directions would not be equal; and this was of great importance in voice production. The position of the false vocal cords above the true cords enabled them to hold the breath back, and so made the pressure above and below equal, and the vibration was equalised, which was the most important point with regard to the intrinsic tone. Until this was realised, the principle was not properly understood. It had been suggested that a school of voice production should be established, or the principles of vocal training recognised, and some means taken for certifying that teachers were competent, and he quite agreed with this. The number of teachers who taught nonsense was greater than that of those who taught sense; at least, that had been his experience. He had known a great number of singers, and many had told him that they had studied the world over, and had not found any one who could teach voice production, or who understood its true principles. It was high time that those principles were recognised, and that there should be some means of ascertaining who were competent to teach.

Mr. NICHOLL, in reply, said Mr. Mahlendorff's remarks produced rather too much pressure against his brain mass for him to be able to absorb his ideas properly, and therefore he would not attempt to criticise them. He had had several conversations with him on this immensely interesting subject, and no doubt each of them hoped ultimately to convert the other, but he could not go into their points of difference further then. He did not think he made the statement about the sound of oo which Mr. Lunn attributed to him. There could be only one sound to a good tone, and on that sound they ought to be able to enunciate all the vowels. If the sound was *ah*, it depended on the quality of the *ah*. A vowel in one sense was only a representative of tone quality; in another sense it was a representative of language. It was an omission on his part not to have mentioned Mr. Lunn's name in connection with the function of false cords, because he knew the good work he had done, and the generous spirit in which he took up the subject. As for a commission of inquiry, it was surrounded with enormous difficulties. He did not believe in methods. He had no secret, but was glad to tell everyone all he knew with regard to the voice. They were indebted to Galen and to men of science from his time onwards, and he did not claim to have discovered anything new. If they could only get professors to keep their own ideas in the background and take a broad view of the question something might be done, but unfortunately personal interests always came in, and while that was the case he did not see any chance of getting a commission which would do any good. He trusted the day would come when some advance would be made, but, in the meantime, all that could be done was for those who had got hold of sound principles to use them in the work they did. If his ideas were based on such sound principles, his pupils would advertise them throughout the world; if they were not, it was no use going in for a commission. Mr. Thorp had corroborated what he had said; he had forgotten to mention the point which he had brought out about the pressure of the air on each side of the vocal cords being equalised, but the illustration he gave of passing from the falsetto to the full voice depended on that fact.

The CHAIRMAN, in proposing a cordial vote of thanks to Mr. Nicholl, said his paper had been most remarkable in every way. He had showed an extraordinary independence of the conventions which had been such a terrible obstacle to progress in the teaching of singing. His thoroughness in investigating the subject from every point of view, his common sense and readiness to see all the possibilities arising from the motion of the air in such a subtle physical substance as the inside of the human throat, made it one of the most luminous and interesting papers he had heard on this subject, and he had heard a good many. He must say, for his own part, he did not welcome the idea of a commission. He need only refer to the case of China, to show what the result might be. There everything was governed by commissions, including the musical scale, and the way in which hymns should be sung in the temples. The scale was arranged some two or three thousand years ago, the system being to tune by fifths, the effect of which was that it was horribly out of tune; but it was all fixed, and could not be altered. Then the twelve scales were allotted to the twelve moons. In the first moon, say, everything started from C; in the second moon, from C sharp; in the third from D; then from E flat, and so on, getting more and more out of tune each time. That was the result of a commission. He preferred perfect freedom for everyone to teach what he believed to be right, no matter how many falsities or absurdities were put forward, for what was really sound and true would ultimately be arrived at. The idea of a commission of voice producers was too delightful; no two of them would agree to the smallest detail, and generation after generation would pass in the same uncertainty. The expense would be ruinous, and meanwhile no one would know what he ought to believe or to practise. He would say let thousands of voices be ruined, but let them have a few De Reszkes and Melbas in the meantime without waiting for a commission.

The vote of thanks was carried unanimously, and the meeting adjourned.

Miscellaneous.

LIGHT RAILWAYS.

The number of applications under the Light Railways Act are stated in *Herapath's Railway Journal* to be twenty-eight, fifteen of which are in England, three in Wales, and ten in Scotland, the following particulars of which are given:—

The longest of the contemplated English schemes is from Grimsby to Saltfleetby, in Lincolnshire, 26 miles in length. The "International Communications, Limited," seeks power to lay down in the Dartford district a line having a total mileage of 22 miles. In Kent, altogether, four lines are projected. Two of these will be exactly of the same mileage —namely 11½ miles—one connecting Ramsgate, Margate, and Westgate, constructed by the Isle of Thanet Railways Company, and the other, the "Hadlow Light Railway," extending from Tonbridge to Claygate-cross and Nettlested, the property of the "Light Railways Syndicate." It is proposed that the Ramsgate, Margate, and Westgate line shall have a gauge of 3 ft. 6 in., and be worked by electricity; while the Hadlow Light Railway will use steam-power on a gauge of 4 ft. 8½ in. Sir William Hart Dyke, M.P., and others, are fostering the "Darenth Valley Light Railway," extending from Dartford to Eynsford, chiefly for agricultural purposes. The length is 8¼ miles, the gauge 4 ft. 8½ in., with steam as the motive power.

Sir Walter Gilbey is promoting a line 11 miles in length, from Elsenham to Bardfield, in Essex. In Gloucestershire a line is projected from Cheltenham to Winchcombe; in Somerset, from Congresbury to Blagdon; in Yorkshire, from Flamborough to Bridlington, and another from Robin Hood to Royal-green Lawn, the latter to be styled the "East and West Yorkshire Union Light Railway." In Staffordshire a line in the Potteries, 14 miles long, is contemplated; in Chester, a line in the Crewe district, about 9¾ miles; and in Norfolk, a line in the Norwich district, nearly 12½ miles long. The London and South Western Railway Company furnishes the only instance in England in which an existing railway company avails itself of the new Act, by promoting the Basingstoke and Alton Light Railway, 13 miles in length. Seven of the English schemes are on the 4 ft. 8½ in. gauge, and in these cases traffic will be interchangeable with the existing railways. In the remaining eight cases the gauges are 2 ft. 6 in., 3 ft., and 3 ft. 6 in.

Three of the Scotch schemes are encouraged by the established railway companies, and it is worthy of note that all the light railways projected across the Tweed are of normal gauge. The most important line is known as the "Cromarty and Dingwall Light Railway," in Ross and Cromarty, 18½ miles in length, to be worked by steam power. In Aberdeenshire it is proposed to make a light railway 17¼ miles long. The Sutherland County Council, the Duke of Sutherland, and others are co-operating to make a line nearly 15½ miles long, extending from Forsinard, through Melvich, to Port Skerra; while in the same county the construction of a second line, to be known as the "Mound, Embo and Dornoch Railway," is proposed. The Marquis of Tweeddale, the Earl of Lauderdale, and others seek power to construct the

Lauder Light Railway, which will be nearly 10½ miles in length, extending from Fountainhall Station to Lauder, Berwick. In Lanarkshire the Caledonian Railway Company desire to make a light line from Elvanfoot Station to Wanlockhead—7¾ miles—and, in conjunction with the North British, to construct another line from Elliot Station to the Carmyllie quarries. The Great North of Scotland Company is projecting a line from Aberdeen to Kirktown of Echt. As a rule all the Scotch lines will utilise steam power.

In the Principality a line of 14 miles in length is projected in Montgomeryshire, one in Glamorganshire, about 12½ miles long, and one in North Wales from Llandudno to Colwyn Bay, 4½ miles.

INTERNATIONAL ASSOCIATION FOR TESTING CONSTRUCTIVE MATERIALS.

The following is the substance of the statutes adopted by the International Congress. The object of the Association is the development and unification of test methods for determining the quality of building and other materials, and improving apparatus for the purpose, by the deliberations of the Association, by congresses, by the publication of a journal, and by any other measures that may be deemed advisable, the necessary funds being raised by the annual subscription of members, profits on the journal, and donations. Candidates for admission must be proposed by two members of the Association, while authorities, constituted bodies and societies will be admitted on their application, which must be addressed to the president. The annual subscription is 5 fr. (4 marks or shillings). Each member, who must undertake (on being elected) to contribute to the success of the Association's objects to the extent of his ability, has the right of voting and also of receiving the journal at a reduced rate. The business of the Association is carried on by (1) the managing committee, consisting of the president, vice-president, three assessors, and members elected by the congress on the proposition of the council, their functions extending from one congress to another—generally a period of two years; (2) by the council, composed of delegates elected by members of the Association in the different countries; and (3) by the congress.

PRODUCTION OF IRON ORE IN GERMANY.

The rapid advance of Germany in all branches of the iron industry, apart from the improved methods of manufacture, is in great measure due to the development of the mineral resources, and the subsequent ready supply of iron ore for the blast furnaces. Unlike England, with an annually increasing import of ore from foreign countries, and unlike the United States, where the ore makes a long journey from the mine to the works, Germany is favoured with an abundance of excellent ore which, it is said, will last for generations to come, and with excellent means of transportation and cheap freight rates. The United States Consul at Annaberg says that the total output of iron ore in the German Customs Union in 1894 amounted to 12,392,065 tons, of which 8,433,784 tons were produced in Germany, and 3,958,281 tons in Luxemburg. As the quantities of import and export are about alike—2,000,000 tons per year—the above total represents the quantity consumed by the smelting works. The imported ores came from Spain, chiefly Bilbao (694,326 tons); Grängesberg and Gellivara in Sweden (572,289 tons); Algeria, Elba, and Greece—all by the way of the Dutch ports. Besides the foregoing, 127,000 tons of ore were imported from Belgium and Holland Native ore is obtained in large quantities only at a few places. The production in Upper Silesia fell off from 723,300 tons in 1892, to 618,552 tons in 1894. According to the view of competent judges, the mining industry of Upper Silesia can hardly exist longer than another generation. The Saxon mines may be looked upon as practically exhausted; the output in Würtemburg is quite unimportant, amounting only to some 10,000 tons yearly. The Bavarian mining industry is chiefly carried on at Amberg, where it yields 40,000 tons of brown iron ore, and at the mines of the Maximilianshütte, in the Upper Palatinate, which have an annual output of 120,000 tons. These smelting works possess further very extensive beds in Thuringia where some 60,000 tons of ore free from phosphorus are obtained. In the province of Hanover much iron ore is produced. The mine of the Ilsed smelting works has an annual output of about 470,000 tons; the Bülten-Adenstedt mine yields 312,000 tons, and the supply is expected to last more than a thousand years at the present rate of mining. The old mines of the Georgs-Marienhütte, at Osnabrück, with an output of 118,000 tons, will hold out for forty or fifty years. The same works mine also 50,000 tons of ore in Westphalia, near Ibbenbüren. The Victoria and Wohherwohrt mines of the Dortmund Union work well, and with good prospects, the annual output being about 80,000 tons. The production of ore in the Weser and Ruhr districts (about 17,000 tons annually) could be considerably increased The only other important iron mines in Westphalia are those of the Hörcler Union, on the coalfields ot Schleswig-Holstein, with an annnal output of 65,000 tons. On the other hand, the Siegerland is rich in iron ore, the output last year amounting to 1,500,000 tons. About two-thirds of the ore is sold to the blast furnaces of that region; the remainder goes mostly to the Rhine and Ruhr. The production of the Dill and Lahn districts, with an output of almost 1,000,000 tons, is very important. Next in order come the Brilon district, including Waldeck, with about 110,000 tons; Gilnhausen (Bieber), with

50,000 tons; Wied (Bendorf), with 33,000 tons; and Dentz-Künderroth, with 25,000 tons. One-fourth only of the product of the Lahn and Dill mines is worked in the district, the rest goes to Westphalia and the Lower Rhine, and partly also to the Saar and the Moselle. The iron districts above named are surpassed, however, as far as productiveness is concerned, by the beds in Lorraine and Luxemburg, which now supply two-thirds of the quantity produced in the whole district of the Customs union. The production of Luxemburg, which in 1870 amounted to 911,695 tons, rose to 2,958,281 tons in 1894. The advance in mining has been relatively more rapid in Lorraine. In 1872 it supplied only 677,659 tons; in 1880, 995,944 tons, and in 1894 its output reached 3,922,052 tons. Thus, within the space of fourteen years, it has almost quadrupled. Luxemburg works 1,300,000 tons and exports the balance—2,500,000 tons. According to this rate of consumption the supply of ore will suffice for one hundred and thirty-five years for the blast furnaces of the country, and fifty-six years for export. The Lorraine district is eight times as large as that of Luxemburg, and recent estimates show that about 3,200,000,000 tons of ore are bedded there, which will last, at the present rate of output, for about eight hundred years. In the question of the ore supply for the blast furnaces of Germany, the freight rates form an important part. Though sufficient competition exists between water and rail to make them extremely low, considerable dissatisfaction is felt by the smelters, especially in the Rhenish Westphalian district, on the subject of the rates, since it has been discovered that Belgium and France are carrying off the Lorraine ores at rates lower than the German. Thus the French Eastern Railway conveys *minette* from Nancy to the Department of the Nord, a distance of about 300 kilometres, at the rate of 1·5 centimes or 1·2 pfennigs per ton and kilometre, while the rate in Germany is 1·96 pfennigs. Only when suitable and cheap means of transportation are created for the German ores will the iron smelters be relieved from the difficulties which they now say surround them.

Correspondence.

PHOTOGRAPHY IN COLOURS.

I am anxious to make, through the medium of the Society of Arts *Journal*, at all events a preliminary announcement of a very remarkable process for producing photographs in colours which was brought to my notice the other day. To say that it enables photographs to be produced in natural colours would not, perhaps, be precisely true, since colouring media are employed; but the result of the process is a photograph in the colours of nature—a faithful reproduction in colour of the object photographed—and so, for all practical purposes, it may be said that the long-sought object of photographic research, photography in colour, has actually been obtained.

The inventor is Mons. Villedieu Chassagne, of Paris, who has developed a process originally suggested by Dr. Adrian Dansac. The following is his method:—(It must be premised that he keeps secret, at all events for the present, the nature of the four solutions he employs.) A negative is taken on a gelatine plate prepared by treatment with one of his solutions. This is developed and fixed in the ordinary manner. It shows no trace of colour. From it a print is taken on glass or paper, the plate or paper being specially prepared by treatment with the same solution. The transparency or the paper print in no way differs to all appearance from an ordinary positive, and shows no trace of colour by transmitted or by reflected light. It is then washed over successively with three coloured solutions, blue, green, and red, and it takes up the appropriate colours in the appropriate parts, these three colours giving, by their various combinations, all varieties of hue. How it is that this power of selective absorption is given to the components of the photographic image (principally, of course, metallic silver) is, it appears to me, the interesting question connected with the process. The action is certainly previously unknown, and it will, as certainly, repay scientific investigation.

As I declined to be convinced by mere inspection of the finished results, M. Chassagne was good enough to demonstrate the whole process for my benefit, and by the kindness of Professor Thomson, of King's College, the demonstration was allowed to take place in the laboratory of King's College on two mornings last week. Professor Thomson and Mr. Herbert Jackson, of King's College, were present on both occasions, and Captain Abney on the second. I must not speak for those gentlemen, but I believe they were as much impressed as I was myself by the remarkable nature of the process and its results.

That such results should be obtained by such a process seemed *à priori* in the highest degree improbable, but obtained they certainly were.

The photographs taken by ourselves were poor, the light (on the morning of Wednesday 20th) being extremely bad. Nevertheless the positives (made by one of ourselves on the following day) showed with perfect distinctness, when treated as above described, the colours of a bunch of flowers I had bought at Covent Garden, on my way to King's College, and of various other test objects.

Our own experiments were confined to gelatine films, but M. Chassagne treated with complete success some paper positives he had brought from Paris. These looked like ordinary silver prints toned with gold, but I omitted to ask about the toning.

Further experiments and independent investigation (for which M. Chassagne has kindly promised me the materials) will, no doubt, throw further light on the nature of the process, but I cannot believe that any investigation will throw doubt on its genuine character, for it was carried out under test conditions last week, the sole reservation being the nature of the materials employed.

I hope that a fuller account of the method may shortly be presented to the Society in the form of a paper, but in the meantime it appeared to me that members of the Society would be interested by having placed before them the first information about so remarkable and promising an invention.

H. TRUEMAN WOOD.

Obituary.

FREDERICK JOHN MOUAT M.D., LL.D., F.R.C.S.—Dr. Mouat, who died on the 12th inst., at his residence in Kensington, was elected a member of the Society of Arts in 1858. He contributed to the *Journal* and was an occasional attendant at the meetings. On February 21, 1872, he read a paper on "Prison Labour as an Instrument of Punishment, Profit, and Reformation: an episode in the Prison History of Lower Bengal;" and in 1888, another before the Indian Section, on "The Origin, Progress, and Influence of Universities in India." Dr. Mouat was born in 1816, and educated at University College London, in Paris, and at the University of Edinburgh. He served in India as Local Government Inspector and Deputy Inspector-General of the Bengal Army, Official Visitor of Lunatic Asylums and Inspector-General of Prisons in Lower Bengal. He was also Professor of Materia Medica and Chemical Examiner to the Government, Professor of Medicine and Medical Jurisprudence, first physician to the Medical College in Calcutta, and Secretary of the Council of Education, Bengal. In 1890-92 he filled the office of President of the Royal Statistical Society. He was author of "An Atlas of Anatomy, with descriptive letterpress in English and Hindustani," "A Manual of Anatomy," and "Hindustani Version of the London Pharmacopæia," also joint author of several works on Hospital Construction, Universities in India, Prison Ethics, &c.

General Notes.

HAMBURG HORTICULTURAL EXHIBITION, 1897.—Some further supplements of the programme of the Gardening Exhibition to be held at Hamburg from May to September, 1897, have been received from the Science and Art Department. Full particulars of the Exhibition were given in the number of the *Journal* for August 28th last (vol. xliv., p. 786).

LENTIL BREAD.—In connection with the Berlin Industrial Exhibition, a baker has been making lentil bread, which is said to possess a highly nutritive value, as well as an agreeable flavour. The lentils are first cleaned carefully, and then ground to a fine flour, to which oil of almond is added to form the paste, which is then baked.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

FEBRUARY 3.—"The Recess Committee: its Recommendations for the Development of Ireland's Agricultural and Industrial Resources." By the RIGHT HON. HORACE PLUNKETT, M.P. (Chairman of the Recess Committee). The Right Hon. JAMES BRYCE, D.C.L., M.P., will preside.

FEBRUARY 10.—"The Chemistry of Tea." By DAVID CROLE.

FEBRUARY 17.—"Light Railways." By EVERARD R. CALTHROP. The ATTORNEY-GENERAL, G.C.M.G., M.P., will preside.

INDIAN SECTION.

FEBRUARY 11, at 4.30 p.m. "The Progress of Science Teaching in India." By PROFESSOR JAGADIS CHUNDRA BOSE (of Calcutta), D.Sc.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

FEBRUARY 2.—"The Progress of the British Colonial Empire during the past Sixty Years of Her Majesty's Reign." By the RT. HON. SIR CHARLES W. DILKE, Bart., M.P. The EARL OF JERSEY, G.C.M.G., will preside.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock:—

FEBRUARY 9.—"Lithography as a Mode of Artistic Expression." By GEORGE MCCULLOCH.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

WILLIAM BURTON, F.C.S., "Material and Design in Pottery." Four Lectures.

LECTURE III.—FEBRUARY 1.

Stonewares.—The results of adding sand to a natural clay; diminution of the plasticity; loss of the more subtle curves, and consequent clumsiness of thrown stoneware shapes—Extended use of *pressing* in moulds, the moulds being generally of pewter or brass, early stoneware shapes are frequently those proper to metal, very distinctly so with the German stonewares—Stamped ornament, incised and scratched ornament particularly applicable to stoneware, which, from its refractory nature, retains the utmost sharpness of detail unimpaired after firing—The various kinds of stamped ornament—Unglazed and glazed stonewares—Salt glaze and its special qualities—Salt-glazed stoneware one of the most perfect forms of pottery—The limited use of colour on stoneware—The position of stoneware in relation to the other varieties of pottery—The stonewares most nearly approaching porcelain—White English salt-glazed ware—The stonewares of Josiah Wedgwood.

HOWARD LECTURES.

Thursday Evenings, at Eight o'clock :—

PROF. JAMES A. EWING, M.A., F.R.S., "The Mechanical Production of Cold." Six Lectures.

FEBRUARY 4.—LECTURE II.—Types of machines—Machines using air as the agent—Regenerative process—Reversed Joule engine—Vacuum machines—Absorption machines—Present-day types.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 1 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. William Burton, "Material and Design in Pottery." (Lecture III.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. Bear, "Wheat Options."

Royal Institution, Albemarle-street, W., 5 p.m., General Monthly Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7¼ p.m. Inaugural Address by the President, Mr. George Maxwell Lawford.

Imperial Institute, South Kensington, S.W., 8½ p.m. Prof. W. E. Ayrton, "Sixty Years of Submarine Telegraphy."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. Alfred Gilbert, "The Sculptor's Architecture of the Renaissance."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Paper by Dr. J. D. Macdonald.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. A. Birrell, "John Wesley—Some Aspects of the 18th Century."

TUESDAY, FEB. 2 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) The Right Hon. Sir Charles W. Dilke, "The Progress of the British Colonial Empire during the Past Sixty Years of Her Majesty's Reign."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. D. Walker, "Animal Electricity." (Lecture III.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Colonel J. Pennycuick's paper, "The Diversion of the Periyar." 2. Mr. H. F. Donaldson, "Cold Storage at the London and India Docks."

Pathological, 20, Hanover-square, W., 8½ p.m.

Self-Propelled Traffic Association, Colquitt-street, Liverpool, 8 p.m. Mr. H. P. Boulnois, "Road Maintenance."

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. G. E. H. Barrett-Hamilton, "General Account of his Expedition to the North Pacific." 2. Mr. G. A. Boulenger, "A Catalogue of the Reptiles and Batrachians of Celebes, with Special Reference to the Collections made by Drs. P. and F. Sarasin in 1893-1896." 3. Mr. Martin Jacoby, "Further Contributions to the Knowledge of the Phytophagous Coleoptera of Africa, including Madagascar."

Junior Engineering, Westminster Palace Hotel, S.W., 8 p.m. Mr. F. A. Nixon, "Dynamo Design, Construction, and Working." (Lecture I.)

WEDNESDAY, FEB. 3...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. The Right Hon. Horace Plunkett, "The Recess Committee; Its Recommendations for the Development of Ireland's Agricultural and Industrial Resources."

Geological, Burlington-house, W., 8 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, FEB. 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Howard Lectures.) Prof. James A. Ewing, "The Mechanical Production of Cold." (Lecture II.)

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. G. D. Haviland, "A Revision of the Tribe Naucleæ." (Nat. Ord. Rubiaceæ.) 2. Dr. Henry Farquhar, "A Contribution to the History of New Zealand Echinoderms."

Chemical, Burlington-house, W., 8 p.m. 1. Lord Rayleigh, "The Oxidation of Nitrogen." 2. Dr. J. J. Sudborough, "Researches in the Chilbene Series I." 3. Dr. J. J. Sudborough, and Messrs. Percy G. Jackson and L. L. Lloyd, "Diortho-Substituted Benzoic Acids III. Hydrolysis of Substituted Benzamides." 4. Dr. J. E. Matthews, "Apparatus for Steam Distillation." 5. Messrs. T. S. Dymond and F. Hughes, "Oxidation of Sulphurous Acid by Potassium Permanganate."

London Institution, Finsbury-circus, E.C., 6 p.m. Dr. Vivian Poore, "The Dwelling House."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. H. A. Miers, Some Secrets of Crystals." (Lecture III.)

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Prof. W. C. Roberts - Austen, "Fourth Report to the Alloys Research Committee."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Hiram Maxim, "Flying Machines and Automatic Guns."

FRIDAY, FEB. 5...Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. 1. Mr. Henry Barcroft, "Partially Immersed Screw-Propellers for Canal Boats; and the Influence of Section of Waterway." 2. Mr. Leslie S. Robinson, "Mechanical Propulsion on Canals."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. The Lord Bishop of London, "The Picturesque in History."

Geologists' Association, University College, W.C., 7½ p.m. Annual Meeting. Annual Address by the President, "The Evidence for the Presence of Man in the Tertiary Period."

Quekett Microscopical Club, 20, Hanover - square, W.C., 8 p.m.

SATURDAY, JAN. 30...Royal Institution, Albemarle-street, W., 3 p.m. Mr. Carl Armbruster, "Neglected Italian and French Composers." (Lecture III.)

CORRECTION.—In Mons. Gautier's paper on "Bazin's Roller Boat," p. 141, col. 1, bottom line, and col. 2 line 1, *for* "18 or 19 knots" *read* "8 or 9 knots."

Journal of the Society of Arts.

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FRIDAY, FEBRUARY 5, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Mr. William Burton, F.C.S., delivered the third lecture of his course on "Material and Design in Pottery," on Monday evening, 1st inst.

The lectures will be printed in the *Journal* during the summer recess.

HOWARD LECTURES.

On Thursday evening, January 28th, Professor James A. Ewing, B.A., F.R.S., delivered the first lecture of his course on "The Mechanical Production of Cold."

The lecture will be printed in the *Journal* during the summer recess.

STOCK PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Stock Trust, a Gold Medal, or a Prize of £20, for competition amongst the students of the Schools of Art of the United Kingdom, at the Annual Competition to be held in 1897.

The Prize is offered for the best original designs for an Architectural Decoration, to be carried out in painting, stucco, carving, mosaic, or any other process.

This Architectural Decoration is to be either for the side of a room or a hall, a ceiling, or the apse or side of the chancel of a church, or any suitable part of the interior of a building.

The designs must be on imperial sheets. Each set must consist of at least a coloured drawing to scale of the whole design of decoration, and two coloured drawings of details on separate imperial sheets. Mere patterns or sketches of details, without the mouldings or borders necessary to make up a complete decorative scheme, will not be taken into consideration. The designs must have been made during the previous school year.

The recipient of a prize awarded under this trust in 1893 cannot compete again.

The designs are to be submitted, with other school work, in the usual manner, to the Department of Science and Art, in April, 1897. Each of the imperial sheets, forming a set of competing designs, must be marked, "In competition for the Stock Prize," *in addition* to being labelled or staged according to the regulations of the Department of Science and Art.

Proceedings of the Society.

INDIAN SECTION.

Friday, January 28, 1897; The Right. Hon. Lord Herschell, G.C.B., D.C.L., in the chair.

The paper read was—

MORAL ADVANCE OF THE PEOPLES OF INDIA DURING THE REIGN OF QUEEN VICTORIA.

By William Lee-Warner, M.A., C.S.I.

Formerly British Resident in Mysore and Chief Commissioner of Coorg.

The Society for the Encouragement of Arts, Manufactures, and Commerce has rendered a signal service to India by recognising to a special degree its claim upon the attention of the public in this metropolis of Greater Britain, whither the nations go up, and whence the influence of an enlightened opinion is diffused throughout the empire. Since the year 1869 more than seventy papers upon Indian subjects have been read under the auspices of the Society, covering a very wide field of observation and interest. As might be expected, the bulk of these papers relate to the development of India's material resources, and to the improvement of her natural products, such as wheat, cotton, fibres, opium, tobacco, cinchona, tea, coffee, silk, forest produce, and the more valuable mineral products, coal, rubies, and gold. Agricultural methods, irrigation, communications by road, telegraph, or railway, and sanitary reforms have received their full measure of discussion; and the more intricate problems of agricultural credit, agrarian legislation, and currency have been the subject of debate and criticism by the highest authorities. The veil has been lifted from the affairs of India's neighbours in Dardistan, Kashmir, Afghanistan, Chitral, Tibet, China, Lushailand, Siam, and Persia; and the prospects of Indian colonisation in Australia, East Africa, and other foreign parts have been debated. Arts have not been forgotten, and those who have attended the meetings of the Society have learnt something about the relics bequeathed to us by fallen dynasties, the architecture of the country, and its social and religious institutions. These chips from the great workshop have only served to illustrate the variety of Indian interests, and it may be predicted with certainty that, for a century to come, the Society will find no lack of Indian topics upon which the British public desire information.

A few words of explanation and apology are perhaps due to you for my choice of subject, *i.e.*, the moral advance of the Indian peoples during the reign of Her Majesty. It is, I fear, a contentious theme, and I must expect to excite a sense of disappointment. Even in the West new principles of morality and new ideals of conduct strike root very slowly, and superficial appearances of progress are deceptive. In India, where time is measured by cycles of centuries, where the people are not only slow to abandon the inveterate traditions and theories of a mythical past, but also view with suspicion and religious horror many of the most cherished doctrines of the impious West, and where legends and superstitions hold the place of history, exceptional caution is required from anyone who seeks to read the signs of the times, and professes to have discovered the working of a new ferment in the inert masses of a stationary population. Yet it seems to me that a glorious reign, which has spanned six eventful decades of Indian history challenges inquiry: and justifies all friends of India in examining how far the principles of our administration have become practical factors in Indian thought and action, affecting the relations of the people with each other as well as with their rulers. A Society, whose aim it is to encourage arts, manufacture, and commerce, must from time to time take stock of the qualities of mind upon which the productive capacity of a nation mainly depends, and must examine the effect and working of those principles of liberty and self-reliance which accelerate the movement from status to contract and give fresh life to industry and progress. Under these conditions the inquiry which I propose to undertake, and those which have been the subject of previous papers read before the Society, have a real interdependence; and although a few sods have already been turned in the narrower field of investigation which I have just indicated, I hope you will agree with me that, whether we are considering the course of papers already read, or merely thinking of the *annus mirabilis* in which we are living, the time is appropriate for the wider survey which I have marked out for this evening.

Some retrospect at four papers already read before the Society will materially assist a consideration of the special problem to which I desire to invite your attention; and as the Society's *Journal* may not have been read by the whole of my audience, I shall very briefly recapitulate their purport and the conclusions drawn by those who have preceded me.

In 1873 Mr. J. H. Stocqueler read a paper on "The Progress of India for the Last Fourteen Years." He was able to record a remarkable advance in education, a liberal extension of railways and roads, the development of forests, and a substantial increase of commerce and cultivation. He drew the inference that new thoughts and ambitions had begun to stir the upper classes, whilst the material condition of the masses was sensibly improved. About their moral progress he was somewhat reticent. Two years later, the Rev. James Long, impressed with the advantages of the Russian system of expansion, illustrated the complexity and difficulty of the Indian problems by dwelling upon the other side of the picture of progress and prosperity drawn by Mr. Stocqueler. Russian success he attributed to the influence which a Slav semi-Oriental power could exercise upon the East. He pointed to the danger of varnishing the upper classes with a foreign education, and spoke of the "Bengal bantlings of a false system of instruction." He feared the effects of a servile imitation of foreigners, insisted upon the tenacious resistance of caste, and urged the rulers of India to revive village municipalities, create tenant rights, and do more to educate the masses in primary instruction, and to foster a native literature. Upon the whole he took a gloomy view of our work in India. The apparent antagonism of the two views put before the Society perhaps discouraged for a time any further pursuit of the subject. In 1881 Mr. J. M. Maclean read an able and most interesting paper on "The Results of British Rule in

India," which was a reply to a discussion then raging in the Press between one set of thinkers charged with taking an official optimistic view of their work in India, and their non-official critics of the "gloomy school," who prophesied the instant bankruptcy of India, a prediction happily not yet fulfilled. Mr. Maclean went so far as to express his belief that "India can never attain independence," and that she owed her undeniable prosperity, as deduced from a careful scrutiny of trade returns and food prices, to the development of railways and reproductive public works carried out by the British; but he attributed to the official classes a love of power, an insensibility to public opinion, and a dislike to private enterprise, which threatened to detract from the good that might otherwise be achieved in the country. The paper gave rise to at least animated discussion; and a long truce was proclaimed until, in 1893, Sir William Hunter applied his brilliant literary talents to a paper on the "Progress of India under the Crown." Sir William did not shrink from any fear of being called an official optimist. He claimed that our rule had made India safe, prosperous, and loyal. It was safe because we had reorganised the army after the outbreak of the Mutiny, had bound together the provinces by the chain of railways and other communications, had erected local defence works, and strengthened the outposts of the empire both by sea and land. By our financial system, and by the introduction of budgets, we had improved India's ways and means, and had established solvency. The public tranquillity was maintained within the country by a careful organisation of the police. British law, the legislative assemblies, education, and a free Press with free discussion had, in his opinion, drawn the people towards us; and the material resources of the country had been so improved that, with peace abroad and tranquillity at home, the condition of the people had sensibly improved for the better.

I have reminded you of these interesting papers for a double purpose. In the first place, I should be sorry to exhaust your patience by repeating facts and opinions which others have set before you in more glowing language than I can, or dare, employ; and in the next I want to indicate, as clearly as possible, the divergence of my route this afternoon from the track pursued by those who have preceded me. Their papers have almost exclusively dealt with the material successes of our rule. I may admit that the distinction between material and moral results is not one which can be pressed too far, since obviously the activities and interests of human life are closely interwoven, and mind and body alike feel the influence of their surroundings. But a lecturer who is honoured with your attention for a single hour is bound to do his best to conduct you straight to the spot from which you can follow the idea which is present to his mind. I must, therefore, leave the beaten track of material results, our striking public works, our noisy commerce, and our obvious statistics of school attendance, and try to catch the echo of the still small voice which, during the past 60 years, has spoken direct to the hearts of the Indian peoples, and whispered to them a message of sympathy and interest in their humanity such as they never before received from their many conquerors. It seems to me that, since our Queen ascended the throne, there have been influences at work in British India which have to some extent altered the tone of the people, raised their level of moral welfare, and improved their conception of duty to each other.

What these are I shall presently indicate, but before I do so I wish to guard against a possible misunderstanding. British labourers in the Indian field may assuredly be proud of their achievements, whether they belong to the official classes, to the great order of merchants, to the public press, or to missionary and benevolent bodies. But any one who insists upon the permanent or far-reaching effects of our railways, our commerce, or even our educational results, must not shut his ears to three warning voices which deter us from placing implicit confidence in such influences: they are the voice of ancient history, the voice of practical experience, and the jarring notes of Indian religions and caste. Unfortunately we learn nothing from Indian sources about the early condition of the country. Strabo, Pliny, Arrian, and Megasthenes in classical times, and a host of British writers in modern times are the spectacles through which alone we catch a glimpse of Indian life. We know that Asoka, the Buddhist King of Behar, anticipated us in preaching the brotherhood of man, but his fallen pillars are almost the only traces left of his life's work. We know again that Vikramàditya, the popular hero and king, who freed his country from the Scythian yoke, the patron of poets and philosophers, raised India to a high pitch of civilisation, but the only certain legacy which he has bequeathed to us is the introduction of the Samwat era, which began in 57 B.C. Imperishable monuments and sculptures of Greek art are still to be found in neglected spots; and when I was in Mysore the spade of a workman in a railway-cutting turned up a number of Roman coins. Where can we find any living traces of Greek and Roman civilisation? India has witnessed the coming and the going of many foreigners, but its power of receiving and faithfully keeping the spiritual influences which they brought with them has been wonderfully small and disappointing.

To-day the friends of India experience what their predecessors have felt, and they still have to deplore the hardness of the crust of Indian society, and its ice-bound indifference to new ideas. Constantly the occasion of a minority offers the opportunity of reforming the whole administration of a native state. I might cite instances where we have established courts of justice, introduced a fair system of taxation, and brought the state in other respects abreast of the adjoining British districts. But the succession of a weak ruler and the incapacity of his subjects to restrain the greed of unworthy ministers, have at times levelled all our boasted improvements, and reminded us that it is easier for us to govern Asiatics well and ensure them material prosperity, than to teach them to govern themselves or to raise their standard of tolerable government.

One cannot then silence the fear that our greatest material achievements may only last so long as they are sustained by British capital and preserved by British troops and British integrity. It is a wonderful testimony to our capacity for organisation that so much of the work of our administration is performed, and well performed, by the natives whom we have educated. But it is generally asserted that, if our directing hand should be withdrawn, there would be a speedy relapse. Education, municipal self-government, and a freedom of writing and of association have, no doubt, made themselves felt, but there are 271 millions in the country who have never yet learnt to read or write; and so long as this dense mass of ignorance and passive indifference remains, it seems to me premature to build too much upon the foundation of our material achievements or of our education of the few. Some streaks of reflected light may penetrate from the upper stratum of educated society into the densely packed multitudes that lie beneath it. But the moral atmosphere of the peoples must be warmed before it can catch the fire of new ideas and ambition lighted from above. Moreover, the believers in the downward filtration theory must reckon with the fact that it is not of advantage to the upper classes that the masses should awake to a new life. The effects of caste and the cellular construction of Hindu society on the one hand, and the social and religious differences which divide Hindus from Mahomedans, and Mahomedans in their turn from other religious classes of the community, interpose a solid obstacle to the transmission from the upper class of Indian society to the masses of the people of new ideas, and especially of those which are imported from the West.

For all these reasons—the hard facts of history, and the unfavourable conditions created by ethnical, religious, and social distinctions—it seems to me easy to exaggerate the moral aspect of our material achievements, and the benefits of our education of the Brahmans and other superior classes of society. The question—whether we have succeeded, where others have failed, in infusing a new spirit into the population, and raising the moral standard of the people, so as to give promise of a permanent improvement in their condition—must then be answered by reference to influences which have acted directly upon the masses. We must look, I think, for the action of forces which are rather spiritual than material, we must listen for voices which have spoken direct to the hearts of the peoples rather than to the intelligence of the few. Looking back upon the present reign of our Sovereign, I should be inclined to give the foremost place in such an inquiry to the abolition of slavery, the second place to the principle of British law, that it recognises no difference between the strong and the weak or the rich and the poor, and the next place to those humane endeavours to protect the weak and relieve the distressed which have been written on the statute-book as well as in the annals of our administration for the last 60 years.

I have always been surprised at the meagre space allotted in Indian histories to the great achievement of the abolition of slavery in 1843, a fact which, I believe, is due partly to the indifference, if not the opposition, of native society to the measure, and partly to the doubt which British officials then, and for some years afterwards, entertained as to the wisdom of the emancipation of slaves. I propose to say something of the extent of slavery and the special characteristics of the institution in India, and then to explain the effects of it, both upon the slave population and upon the rest of society. For further information I refer you to two bulky returns presented to the House of Commons on April 6th and April 26th, 1841. The sources from which the slave market was recruited, namely, birth, marriage, debt, and distress, indicate at once the vast extent to which it prevailed. The enemies of the Aryans, the unbelievers in the gods of the Veda, were the Dàsyus whom India gave over to destruction, and from Dásyu was derived the word which, at a later date, signified slave. The connection thus established by language is not peculiar to India. As in other countries, the first slaves were, no doubt, the conquered races; and in India, where caste prevailed, it was inevitable that slavery should become hereditary. The laws of marriage worked hand in hand with the law of birth. The Hindu system resolutely opposed marriages between one caste and another, and at the beginning of this century it was still the universal rule that the children of slave mothers must be slaves. Even when a male slave had been emancipated he often reverted to slavery because he wished to marry a slave girl. If a high caste Hindu married a free woman of low caste the offspring in most parts of India became slaves. Such unequal marriages were infrequent, and as the mortality amongst slaves by birth was considerable, it is obvious that the servile ranks needed recruitment from other less precarious sources. Of these, debt and famine were the most fruitful, for the trade of the professional kidnapper was reserved rather for children, specially females, of a better class than the common labourer. As regards debt, it must be remembered that under the native governments the land revenue was collected with great rigour, and if torture or exposure to the sun with a heavy weight tied on the defaulter's back failed to squeeze out payment, the peasant and his family were sold into slavery. To avoid this consequence, free-men sold themselves and their children to a slave owner of their own choice. In a report by the officer in charge of Hazaribagh, written at the commencement of the Queen's reign, you will find this incident narrated:—"I had a case before me in which the amount stipulated in the bond was only one rupee, and the amount of debt for which persons will sell themselves is generally less than 20 rupees." Times of distress occasioned by locusts, floods, or failure of rain were more frequent in the last and the first half of this century than they have been since then, and on such occasions the market was overstocked. The reports on slavery presented to Parliament in 1841 give several instances of the purchase of a slave for one rupee, and in Agra, in 1813, a boy was sold by his parents for a single meal. Free people gave themselves and their families away in the famine of 1790, in Cuttack. When the districts to the south of Calcutta were inundated, in 1834, children were hawked about the streets of Calcutta and its suburbs. A few figures will convey to you some idea of the prevalence of slavery. In 1841, it was estimated that 25 per cent. of the population of Tipperah, 33 per cent. of Sylhet, 60 per cent. of that of Cuttack, and about 150,000 persons in Malabar were slaves. During the famine of 1813, in the Agra district, half the free population disappeared. The extent to which slavery prevailed varied very much in different provinces and also in the different districts of the same province, but there is enough evidence to show that the servile population numbered several millions. The price of a male adult seems to have varied from 5 rupees to 30 rupees in ordinary seasons, and rich zemindars usually counted their 2,000 slaves.

There were, however, two features of slavery peculiar to India which greatly mitigated the lot of slaves as compared with that of slaves in Africa or in the West Indies. The first was the sanction which religion gave to slavery, and the second was the institution of caste. The Hindu religion attributed to the favour of their gods the provision of slaves. Major Walker, writing in 1833 about the Malabar province, gave this account:—"The Brahmans, when Parashram divided the lands amongst them, represented the need of assistance for cultivating them. So Parashram collected the wild people from the jungles and presented them to the Brahmans as *jenm*, and as *jenm*, or absolute property, the Chermas remained, being sold, leased, or mortgaged as freely as the cattle on the land." The writer continued:—"The absolute proprietor, by the ancient laws of Malabar, is accountable to no man for the life of his own Chermas, but is the legal judge of their offences, and may punish them by death if they appear to deserve it. The mortgageor may only chastise them." The treatment of their slaves by the natives was generally humane, and the Hindu religion, which protects cows from slaughter, extended its benevolence to slaves as well. They were even allowed with their scant fare some small delicacies. In Cuttack an allowance of tobacco to the value of about two shillings a year was doled out, as appears from the following bill of fare:—" For his daily food the slave gets one seer of rice, half a chittack of salt, one quarter of a seer of dal or a pice to buy vegetables, two pice a week for tobacco, and half a pice a day for firewood." The condition of household slaves was often comfortable, and that of the outdoor working population was tolerable. The Indian naturally possesses a gentle disposition, and it is only fair to him to admit that it was largely due to the rougher treatment of their slaves, which was anticipated from European masters, that the British authorities realised the necessity at last for altering the law of India on the subject of slavery.

The Hindu slave proprietor not only treated his slaves as gifts from Providence, who should be used as kindly as his cattle, but with wise foresight he introduced caste into their ranks, thus sowing the seeds of disunion, whilst emphasising the superior sanctity of the Brahman. In Bengal slaves of the better castes were herded apart from those of the more degraded classes. Mr. Graeme gives this account of caste distinction in Malabar:—" The rules of Malabar prescribe that a slave of the castes of Poolyan, Waloovan, and Parian shall remain 72 paces from a Brahman and a Nair, and 48 from a Teean; a slave of the Kunnakan caste 64 paces from a Brahman and a Nair, and 40 from a Teean; and the other castes generally 48 paces from a Brahman and from a Nair, and 24 from a Teean." Other writers report that the Poolyans might not go upon the roads, for fear of polluting travellers or the houses situated on it. As a general rule the slaves of degraded castes were not allowed to enter the villages or inhabited settlements of their fellow men. Yet the majority of their fellow men who treated them thus must have constantly had the fear of slavery presented to their minds, for their rulers regarded it as no part of their public duty to make provision against famine. Whatever visitations of storm, locusts, or failure of rains Providence might send, one result was certain, the slave market was filled, and slaves were cheap.

Meagre as is the account of slavery which I have given, it may enable you to form some opinion of its mischievous effects, first on the slaves and then upon society. From the point of view which I am now taking of the moral condition of the people, the Indian system of slavery seems to me the most ingenious device ever invented by society for suppressing any upward movement of the people, and destroying a nation's manliness and independence. Its very mercies and kindnesses tended to aggravate the degradation of society. Three influences have in other countries induced slaves to emancipate themselves—a spirit of revolt against cruelty, indignation at the treatment of their women, and combination. The masters' lash was wanting in India to drive the slaves into rebellion. The slaves were kept on low diet, like their masters' cattle, but they were not habitually ill-treated. Their women, it is true, were used as their masters pleased. But every ordinance of religion and caste assigned to women a position of special degradation. The slave woman dragged down the son of a high caste father into slavery. A woman was treated, even when free, with mistrust and contempt, and as a slave she must expect what she got. No indignation could be justified where " only a woman " was concerned. Finally, any combination of slaves was impossible where the several castes of slaves, degraded to the level of cattle, were exalted, one above the other, in respect of the number of paces to which they might approach a Brahman. In fact, the kind treatment of the master and the paltry concession to human vanity of gradation of uncleanness in the servile ranks, acted like a narcotic in stilling the natural instincts of man for freedom and improvement. The ordinary slave, as he looked out upon the free labourer, over whom the sword of famine hung, was not merely content, but self-satisfied that he had not reached the lowest depth of degradation in which the Poolyan lay. As for the Poolyan, he had not merely his master's opposition to face, but that of the slaves above him in the servile scale, if he dared to think of freedom. Every incentive to self-help or progress was stifled; and even the fighting power of society was weakened by the semi-starvation in which the labouring classes were kept. The victory of Plassy becomes intelligible when the state of Bengal society is considered. But there is no necessity to theorise when we can turn to the facts of history. The East India Company, if it recognised slavery, at least hesitated to employ slaves on its own account. On one historical occasion it emancipated its slaves in Coorg, and the view which the slaves took of the transaction illustrates their sunken condition. After the conquest of Coorg, in 1834, the first problem was what to do with the slaves whom the deposed Rajah had employed upon his estates. The local officers were opposed to emancipation as likely to alarm the native proprietors of slaves. The Governor - General, however, determined to follow his own principles, and 1,115 slaves were set free. To some were assigned plots of land to cultivate, and to others was given a small sum of money to start them, and to all were offered certificates of freedom. Only 30 families took to cultivation on their own account, and 250 accepted service under peasant proprietors. The rest re-entered of their free will the servile ranks, and in the words of the official report, "were treated exactly as if they remained slaves, many of them destroying their certificates of freedom." It required more confidence in the British Government and in its power to fight famines than the people possessed sixty years ago, to induce the slaves to trust themselves to freedom.

The slaves can hardly be blamed for their moral despair and contentment with their degraded lot. Slavery had even demoralised British officials, who regarded it as the inevitable result of the famines to which the Indian climates and seasons are liable. Mr. Chaplin, in 1820, declared that it was a hopeless idea to think of stopping the slave trade. In 1826 Mr. Elphinstone, a man of rare enlightenment and humanity, reported to Government that he was in favour of stopping the exportation and importation of slaves in ordinary seasons, but that an exception must be made in seasons of famine. Seven years later, Mr. Remington, a district officer in Thana, gave up without protest some servants in the employ of Government, because they were claimed by a man who had bought their fathers in a year of distress. Magistrates, and even political officers, felt themselves bound to recognise a property in human beings which the Hindu and Mahomedan castes allowed; and so long as they viewed slavery as the only system of relief from famine, they took a lower view of the duty of Government towards the people of India than is now accepted.

Upon society at large the influence of slavery was particularly injurious. The slave owner was to be found in the person of every large Zemindar, and most of the well-to-do householders. The upper classes habitually regarded large masses of the population as outside the protection of the law, and little better than cattle. The public feeling in respect of women was most degrading. Female children as well as adults were sold into slavery without the pressure of famine or the excuse of conquest. Husbands sold their wives from motives of enmity as well as gain. The selling price of girls and women was at all times from four to ten times greater than that of males. When the British Government stopped the importation of African female slaves for Zenana purposes, the native Courts obtained their supplies from the British districts. The demand naturally produced that frightful crime known variously as Thuggee or Megpunnaism. Gangs of murderers travelling with their wives and families traversed the country, and pretending to join travellers for the sake of security and mutual protection, murdered the parents at night and kidnapped the children. The girls were sold at 20 Rs. a head, the boys at 5 Rs., and frequently they were the children of respectable and well-to-do natives. Thus slavery was responsible for cold-blooded murders, enforced prostitution, and for the maintenance of a low tone as to the sanctity of life and the rights of women which has not yet vanished from Indian society.

I could give you, from my own experience, instances of reckless disregard of human life, such as the murder of an old Mahomedan pilgrim at Miraj, in order that two Hindu peasants might bring good luck to their well by sprinkling his blood upon it. But any one who desires to see modern traces of the vicious sentiments which slavery fostered can find them in Blue-books. In the Bengal famine, which occurred twenty years ago (see the "Moral and Material Progress of India," 1867-1868, p. 29), it was reported that a large number of British subjects were being sold into servitude in Nepal; and more recently in Manipur the British Government interfered to prohibit slavery. As the red line of British responsibilities advances, whether on the Burmese or on the north-western frontier, we are constantly reminded that on all sides of us the demoralising custom still prevails, and that without our continued presence in India, society might relapse. But at least I believe that we have gained an important point, and that the measures taken in the early part of the Queen's reign have broken the spell in British India which religion and the selfishness of the upper classes had cast upon man's proper instinct of freedom and progress.

I must now briefly explain the course of our legislation on the subject, and I select the Western Presidency as being that upon which the public opinion of the West acts most powerfully. The first step taken in Bombay was to deal with the foreign trade, and in 1812 the importation of slaves for sale was forbidden by regulation. By the year 1820 we had acquired the Deccan by conquest from the Peshwa, and by an executive order the sale of slaves was prohibited. But the Legislature was not prepared to go so fast, and the law, known as Regulation XIV. of 1827, recognised the sale of slaves as legal if the sale was duly registered in the magistrate's court, and if the slave was 10 years old. Seasons of famine were, however, left without these restrictions. In other provinces there was the same hesitation to stop the human traffic, and the necessity for allowing it to continue in seasons of scarcity was everywhere recognised. But after the succession of Her Majesty to the throne a comprehensive report on the subject was drawn up, and in the sixth year of her reign a law was passed for the whole of India which, without formally abolishing slavery, emancipated the slaves and destroyed the power of the slave owner. In four short sections the law abrogated all distinctions between the slave and the free man. It prohibited the sale of any person, or of a right to his labour as a slave by any public officer in execution of a Court's decree. It forbade the magistrates and the judges to enforce rights arising out of an alleged property in slaves, or to dispossess any person of property because the proprietor or the devisor of it was a slave; and it enacted that any act, which would be a penal offence if done to a free man, should be equally an offence if done to any person on the pretext of his being in the condition of slavery. In short, the law of 1843 refused to be an instrument of slavery, and it opened the doors of justice equally to all subjects, whether bond or free.

Many of our achievements, obvious as they are to ourselves or to the educated classes, fail to impress the ignorant masses of the Indian population. But the law which killed slavery directly affected the lowest and most numerous classes of the people. Their admission to civil rights and to the protection of law carried right down to the depths of the social system a new principle of administration which neither priest nor zemindar could conceal from their view. To every hovel, to every plantation, and to every estate, the tidings were brought, no matter whether at the time they were received with gladness or indifference, that the Sirkar took an interest in the common people, and recognised them as its children. The dullest could not fail to experience a new sense of personal right and self-respect, or to feel that a stronger power had arisen in the land which could battle on their behalf with the selfish traditions of the priestcraft. The corroding influences of slavery—the spectacle of children sold into slavery, of women surrendered to the lust of the rich, of families murdered on the highways by the professional kidnapper, and of law and justice denying redress to the weak—were suddenly arrested; and the Indian peoples literally awoke in 1843 from the sleep of centuries to a new life.

No doubt the full effects of the measure are not yet realised, and it is not out of place to examine some of the moral characteristics of Indian society which have been bequeathed by the institution of slavery. The absence of thrift and enterprise in the working classes, and their toleration of oppressive customs are the natural outcome of their former servile condition. The contempt in which labour is held by the upper classes, and their too often callous indifference to the poverty and distress of the depressed classes are what might be expected from slave proprietors who have lost the powers which Pareshram conferred upon them over their *jenms*. The zemindars in Bengal who oppose tenant right, or the Brahmans who object to the education of the Mhars cannot forget the day when the land was tilled or menial services performed by slaves. The denial to women of any social or personal rights, which found expression in the opposition raised to the abolition of Suttee, and to the age of consent Bill, and to reforms in the matter of child marriages or widow remarriage, is not surprising in a society where children and women were kidnapped and sold into slavery, and either kept for immoral purposes or employed in the most repulsive of duties. Even the absurd pretensions of caste distinctions, which honeycomb society down to the ranks of the depressed castes, were sedulously fostered by the Indian system of slavery. I recollect a revenue official protesting to me, during the famine of 1876, that it was wasteful expenditure to spend money in famine relief; and he maintained, with truth, I believe, so far as the advanced classes are concerned, that the British Government would gain more credit by applying its funds to the relief at home of poor families of the upper classes, than by attempting to prevent the death of the masses from starvation. In 1885, as I came out of a missionary school at Ahmednagar, I was severely criticised by two high-placed subordinate judges, one of whom was a conspicuous adherent of the Congress. He urged that it was positively mischievous to educate Mhars and Mangs, because it made them anxious to set up as agriculturists, and disposed to question the authority of their betters. He mentioned, as an instance, that village watchmen would no longer run errands at the command of a Brahman, or work without receiving a wage. I can recall an occasion when a native magistrate inflicted a fine of a few rupees, or in default a day's simple imprisonment, upon a man who had broken his child-wife's arm, by deliberately putting his foot on it, and then breaking it, because she had not given him satisfaction in her performance of household duties. When I called for an explanation, he honestly admitted that he was of opinion that a woman should not appeal to the Courts for redress against her husband's acts. I mention these incidents, because in each case the spokesmen were men of education and position, and their remarks are representative of the survival of a tone which I cannot but attribute to the degrading influence of ages of slavery upon the proprietors of slaves. If you turn from the slave-owning class to the ranks of the people whom we emancipated, you will find in them the effects of centuries of ignorance and superstition. Even to-day there are backward colonies of the people which cannot believe it to be impossible that Government should require their heads, or their children's heads, for sacrificial purposes. A Bombay vernacular newspaper on the 1st of August, 1896, gave an account of a widespread panic that the authorities were collecting a pile of heads for the foundation of a bridge which had been carried away. I recollect, in my own experience, a similar belief that children were being spirited away by Government, which was not abandoned until an old woman was discovered in the act of murdering a child for its ornaments. She confessed that she had obtained thirty rupees by the sale of ornaments taken from some twenty children, whom she had killed, and she showed where their bodies were hidden. One cannot wonder at this mistrust of Government when, for so many centuries, the most elementary personal rights of man were denied to the servile classes of society by their former rulers. But these social distempers to which the long prevalence of slavery has exposed parts of Indian society will, in course of time, find a remedy in the education of the upper classes and in the constant experience of British administration by the lower classes. They do not detract from the law of 1843, or weaken the force of the striking proofs then given to the Indian peoples of the care of the Indian authorities under the Queen for the welfare of Her Majesty's subjects, even those of low degree.

I must now pass on to a consideration of the second great educative influence which has been at work amongst the masses of the Indian population since the accession of Her Majesty, namely, the British system of law. I refer, not so much to its purity or the alleged excellence of its administration, as to the fact that it offers justice and defence to all persons, irrespective of caste or position, and even allows its officers to be sued or tried if they break the law. I may at once confess that, in the eyes of the masses, our administration of justice is far from perfection, and the lower classes constantly complain of the difficulty of finding a British magistrate, now that the doors of the public services are so thronged by educated natives of high caste. The law's delays and the law's expenses are not popular with people who are so given to litigation as the Indians. Even the boasted impartiality of British courts is not admitted without large reservation. The unsuccessful suitor in India blames his luck or the judge's error, and not his cause, for any failure to win a decree in his favour. Europeans themselves at times wonder at the verdicts of European juries, where the accused are Europeans. The people of India can hardly believe that a Brahman judge or a Brahman magistrate can be impartial where a Brahman is concerned, or in a religious dispute where religious feelings come into play That a man should favour his friends is believed to be only human and natural. There exists to day in India the sentiment, attributed to a learned British judge, who heard the rectitude of Cromwell's judges extolled, "Devil thank them for their impartiality!" said he; "a pack of kinless loons. For my part, I can never see a cousin or a friend in the wrong." I myself believe that there are many uncorrupt and impartial native magistrates in India, but I am sure that the common people do not credit them with the virtues they possess. Accordingly, our British administration of justice finds many critics and detractors, some of whom have right on their side, when they complain of the laws' delay or its cost, or even its occasional aberration from justice.

But despite these objections, there are two features of British law which are in abrupt and happy contrast to any experience of justice which the Indian population ever before enjoyed, and which have worked a revolution in their ideas. The first is the subjection of the executive to law, and the second is the application to all degrees of men of those principles of equal dealing, of which, in the words of Sir Henry Maine—uttered in the Viceroy's Council on March 31, 1866—"we are in India the sole depositaries." We need not go to the past to see the working of the native system of law. For the native States, although they have made rapid advances in improved administration, still retain some features of the old order, which will illustrate my contention. In a native State the ruler's commands are law, and besides being his own legislature, he is the highest court of appeal. It is a sufficient answer to any alleged infringement of private right that the ruler's officer acted by command. In British India, on the other hand, the right of Government to revise, for instance, the assessment of Canara, to levy a tax, or resume private property, can be contested, under British law, by the humblest ryot, and must be determined by a court of law, with whose judgment the Government cannot interfere. The independence of the High Courts has at times even provoked a conflict with the executive, and thus helped to illustrate, in the most marked fashion, the respect paid by the British Government to its courts of justice. The effect of such a lesson upon the people of India cannot be exaggerated.

Equally patent to the most ignorant of the population is the equality of men in the eye of the law. No doubt there is not, as there never yet has been, any uniform system of law in India, applicable to all the races which have settled in the empire. There is none such, even amongst the Hindus, and the Privy Council has laid down the doctrine that clear proof of usage will outweigh the written text of the law (xii. M.I.A. 436). The Mahomedans regarded their own code as appropriate only to those who professed the tenets of Islam. In all questions as to succession, inheritance, marriage, caste, or religious usage (and what an immense field of litigation they cover!) Mahomedan, Hindu, Buddhist, Christian, Jewish, and Parsi law, unless altered by legislative enactment, is followed; and where this fails, any custom, if such there be, having the force of law, and governing the parties or property concerned, forms the rule of decision, and in cases where no specific rule exists the Courts act according to justice, equity, and good conscience. In 1873 a special marriage law for the Bramah-Samaj body of Hindu Dissenters was enacted, and in other instances the Legislature has intervened by special legislation to meet the requirements of particular creeds. Thus the tendency of both legislation and judge-made law is centrifugal, and tends to divide rather than to unite into a single nation the various races of India. But the dominant British power has, unlike its predecessors, applied to all parts and races of India certain codes, such as the Indian Penal Code, passed in 1860, the Code of Civil Procedure, passed in 1859, and that of Criminal Procedure passed in 1861, which have been since then amended, and certain laws of evidence and contract, which treat all the subjects of the Queen Empress on an equal footing. The idea that the same presumptions of innocence or credibility should apply to the poor and the low-caste as well as to the rich, the Brahman, and the Mahomedan noble is a foreign principle of immense educative force, which the British Government has introduced. One is reminded of its power by events which still occur in the native States where the old order has out-lasted changes in British India. A case lately occurred of murder committed by a Brahman, who had killed the son of a rival in order to spite the father who had supplanted him in an office in a small native State. It happened that capital trials were being conducted by the political agent. The murderer was sentenced to death and the occasion was the first upon which, in the memory of man, a Brahman had been executed under native rule in that State. The ruling chief, who was a Hindu of non-Brahmanical caste, was so apprehensive of the feelings which the execution would excite amongst his Brahman subjects that he left his State until the sentence was carried out. I refer to this incident as it illustrates the far-reaching influence of the vindication of equal justice. There was not a village in the State in which the incident was not discussed, and the lesson that British law is no respecter of persons was taught at once to the whole population without any agency of press or printing. Next, after the abolition of slavery, the equal enforcement of the penalties of British justice, and the equal protection which it accords to all alike, are moral principles of public notoriety, which have carried straight to the masses of India a new conception of the rights of man and of the duties of Government.

I pass on to the third of the influences exercised by British administration which has made itself felt in every corner of the empire, and particularly among those classes of society which read no papers and take part in no political agitations. Throughout our administration there breathes a spirit of benevolence and humanity that appeals forcibly to the hearts of the population and makes itself felt in the relief or advancement of the people committed to our care. It finds expression in the organisation of costly campaigns against famine, in sanitary improvements which are received at first with dislike, and in time welcomed by the people, in the provision of dispensaries and organisations like Lady Dufferin's fund for sick women, in laws for the protection of labour or emigrants, in the reclamation of criminal classes, in prison reform, and in measures and enactments designed for the mitigation of those sufferings which Indian women have for generations endured. Some of these measures are not popular, being in advance of public sentiment, but we never should have reached the point of moral progress which we have attained had we waited for public approval. For instance, the abolition of Suttee still raises unfavourable comment in some quarters, although the language once used to me by a conservative gentleman of Poona is not often repeated. He bitterly remarked that the British Government might deceive itself as to its success in interfering with a grand custom, "for Hindu society could revenge itself by methods of which the police never heard." Such language, I believe, would be condemned by most educated men. Still I have heard many sober Indians arguing to the effect that India has lost virtue by the prohibition, and that womanly character has deteriorated owing to the suppression of acts of heroism and spiritual exaltation which Sutteeism supplied. I know of an instance which occurred not long since in the Punjab, where a widow deliberately set fire to straw in an outhouse, and so followed her husband to another world by self-immolation. Such dramatic scenes appealed in the past, and will always appeal to human imagination. Religious fervour, the fidelity to a husband which courts death, and sublime self-sacrifice deserve to excite admiration. But all merit in self-immolation was lost when an unwilling victim was led like a sheep to the slaughter, and when the public conscience was repeatedly demoralised by the public exhibition, and by the perverted approval of cold-blooded murders of defenceless widows. We have protected such from a horrible fate, and, above all, have done incalculable good to the spectators, by prohibiting the enforced sacrifice of widows. Our efforts to alleviate human suffering by dispensaries, hospitals, and the provision of nurses were for a time misrepresented, but now they are cordially acknowledged by the hearts of the people. From the latest report issued I observe that in the Bombay Presidency alone, numerically the smallest of the large Indian provinces, there are 306 hospitals and dispensaries, at which last year 2,382,069 cases were treated. The bulk of these patients were drawn from the lower ranks of the peoples whose children in our secondary schools are a microscopic quantity; and it needs no words to bring home to you the widespread influence of medical relief, not only in its physical, but in its moral results. In connection with this subject Lady Dufferin's nursing fund deserves, and will receive, the notice of history. The solicitude of the highest lady in the land for the welfare of Indian women, publicly proclaimed as it was to Indian princes and nobles, and by means of their liberality translated into ways and means for the alleviation of distress in several centres of the empire, has formed an object-lesson in the benevolent purpose of British administration, which was suggested as much by an inspiration of political genius as by a sisterly heart.

Time and your patience would fail me were I to enter into a detailed account of the other measures which I have already enumerated as spreading through the Indian peoples an idea that they are cared for by their rulers. But as to one of them, namely, famine relief, I may draw your attention to the contrast between the then and now. Then, the indigenous system of famine relief, by means of voluntary sale into slavery, which we found in the land, and which our officers regarded as the natural remedy at the beginning of this century; and now, the campaign for saving life and preserving freedom, which the Queen's Viceroy is vigorously waging against famine in almost every province of India. Then the free population drifted into slavery, in which state it received a miserable dole of food. Now the starving classes are kept alive by a more generous grant of food, which they have the satisfaction of earning, and they pass back into the ranks of freedom. The two methods, the native Indian and the British, are in the most abrupt antithesis to each other. The combined forces of British finances and of British organisation in every department of the administration, are now marshalled against the lamentable effects of a failure of the rains, for which no human Government can be responsible. No doubt native ignorance of the laws of supply and demand, and prejudices against the local grain merchants, involve complaints against our measures, and starving men are impelled here and there to riots and robberies; but the masses of the people understand well, and gratefully admit, the efforts which British officers are making on their behalf.

I might follow the course of legislation during the past 60 years, and point out the footprints on the sands of the statute-book, which indicate clearly the benevolent direction of British policy. But time prevents more than a brief enumeration of a few Acts of the Indian legislature, which must tell their own tale. The following bare list must suffice:—

Various Acts to suppress Thuggeism, passed in 1837, 1839, and 1848; Acts to regulate emigration, passed in 1839 and 1864; the Act relating to slavery, passed in 1843, and another dealing with dacoity; Acts against gambling and lotteries, 1844, 1851; an Act to suppress Meriah sacrifices, 1845; Act relating to wandering gangs of thieves, 1848; Act saving forfeiture of rights for loss of caste; an Act relating to re-marriage of Hindu widows, 1856; several Acts for improving jails, and for the proper custody of lunatics; the Act for suppressing infanticide, 1870; the Reformatories' Act, 1876; a Factories' Act, 1881; the Age of Consent Act, 1891; and Act for preventing cruelty to animals.

This list takes no account of educational or self-government Acts, which have done so much for the country, but it shows a steady progress in legislation intended to relieve distress and to assure the weak and oppressed of the solicitude of Government on their behalf. There are many who think that Government ought to have legislated more boldly in the direction of social reform, but the reluctance of the native States to follow our lead in many of the Acts which we have passed, and the steadfast opposition of some classes to the advance of the masses, as well as the ignorance of the latter, interpose barriers to any rapid progress which a sensible Government must recognise. Something must be left for Indian society to perform by its own effort, and deeply as I regret the hostile attitude towards social reform which the Indian Congress has adopted the fact only emphasises the need for caution. Meanwhile I venture to think that the abolition of slavery, the equal defence which our laws have accorded to all Indians irrespective of religion, caste, or position, and the sedulous endeavour made to alleviate distress and protect the weak during the reign of Her Majesty have proved powerful levers in raising the Indian peoples to a higher moral level. If we still have to wait for a general reformation we need not shut our eyes to the tendencies of a reformation visible on all sides.

I have frequently asked native gentlemen about their view of the Indian peoples, and I think I shall accurately represent the outcome of these conversations if I put their case as follows. "Your public works," I understand them to say, "fill us with admiration and wonder. Your efforts in the cause of education have not much altered the relative positions of the classes to each other or to Government. The castes and races which formerly monopolised the power and place that education and heredity secured for them still hold the field. You have created legislative assemblies and self-government boards, but the new positions in municipal or rural assemblies, as well as the old places in the service of Government, are exclusively held by the advanced classes, and the masses of the population are still governed by those who always ruled over them. No doubt your officials are better trained and supervised, and your system of law and justice is free from general corruption. You have weakened the power of religion and inveterate customs. The influence of the priest and of the priestly caste no longer rests upon the sanction of religion. Towards the divinity the attitude of all classes has changed, and faith in the Hindu religion is sensibly weakened. There is an obvious conflict between the Vedic teaching as to Brahmanical rights, and the actual position of low castes and the practical operation of British law. The upper classes have learnt that the traditions of their elders do not accord with the facts of nature, and their confidence in their religious teachers is shaken by their schoolmaster's lessons. Railways have weakened caste, and soon the black sea will be crossed with impunity. Women have been taught that they have rights as well as men, and the abolition of Suttee has worked a revolution in the household. The ignorant masses accustomed to resign themselves to fate and the will of the gods, are being taught to look to an earthly providence by a Government which refuses to accept famine and pestilence without resistance and without an effort to mitigate the divine punishment. Nay, it even anticipates and neutralises the effect of natural disasters such as the Gohna landslip. The spirit of independence and self-assertion which your laws have excited has invaded the family. The parental authority is weakened. Children are more open and observant, more inclined to ask questions than to accept the commands or doctrines of their elders. They want to know the why and wherefore; they leave their villages and travel; and they are ready to desert their father's occupations, and to seek for change and betterment. The natural rulers of society have lost their hold on the younger generation, and if you want to carry the people with you, you will find to your cost that the priests and head-men can no longer draw the masses after them. You have in fact destroyed authority and disorganised society, and yet the country is not the happier for the change. The Press finds fault with all you do, and when famines or other national disasters occur, the blame is transferred from fate, or an enraged divinity, to the shortcomings of a Government which has taken upon itself the whole responsibility."

Such are, to the best of my belief, the views which the Indians take of British rule. But it seems to me only to amount to this, that there is a new spirit infused into Indian society, a movement from status to contract, a breaking with the traditional passivity and immobility of Indian society, in which the masses formerly accepted the upper castes at their own estimate, and were content to be slaves. A general restlessness and appetite for improvement are not in themselves bad qualities. A readiness to examine traditions and anomalies, and an impatience under the barriers of caste and superstition, promote a healthier tone of society and a higher view of the possibilities of life. No doubt administration is rendered more difficult, and the frequency of religious disputes shows that religious parties know their legal rights, and mean to assert them. But it is surely to our credit that the voices of the depressed classes, of women, and of the common people, should be raised on their own behalf. Men are no longer content to be slaves, and a new current stirs the stagnant pools of Indian society. Wants are felt, and the next step of formulating reforms will in due course follow. At least, all classes demand more from Government; and millions of the Queen's subjects, whose fathers lived a hard life, and patiently endured in silence gross oppression, have felt the thrill of hope and desire. I venture to think that when the history of the Queen's reign is read by the light of the events which the coming century will unfold, it will be felt that the hope, so often expressed by Her Majesty the Queen-Empress, that she desires "anything which may tend to brighten the lives and ameliorate the condition of her poorer subjects," has been no mere phrase, but has been translated into actual facts, and been written upon the statute-book and the public administration of India during her reign. No doubt the Indian peoples have yet to be regenerated by forces which lie outside the sphere of Government, and which rest with a Higher Power than an earthly Government. Perhaps I have disappointed those of my hearers who expected me to touch on that great subject. If such is the case, I will only raise one plea in my defence. I might have approached the question of moral progress from the side of education. Two difficulties, however, occurred to me. To one I have already called attention, namely, the overwhelming preponderance of illiterate ignorance in India, and the obstacles in the way of filtration from the upper classes to the masses. But the late Sir Henry Maine, in his Calcutta Convocation address, delivered on March 11, 1865, pointed out another difficulty in these words:—"So far from intellectual growth being in itself certain to destroy error, it constantly supplies it with new weapons. We may teach our students to cultivate language, and we only add strength to sophistry; we teach them to cultivate their reasoning powers, and they find a thousand resources in allegory, in analogy, and in mysticism for evading and dircrediting truth." With such an outcome of intellectual training before me, I preferred to search elsewhere than in education for the discovery of forces which by acting directly upon the peoples of India may have become practical factors in Indian thought and action. The touch of nature which makes the whole world kin, the emancipation of human labour, the recognition by the law and by the executive of the rights of all subjects to protection, and the tender human sympathy extended to the suffering masses in their contests with famine, distress, or sickness, these all seemed to me influences of universal and unquestionable power. They are intelligible to men without education and without reference to filtration. They are the voice of humanity and of nature which men instinctively hear and understand. For that reason I have ventured to press them upon your attention, and I would even ask you to agree with me that they constitute a sufficient justification for applying to the Victorian era of Indian history the words of not the least of the poets of that period—

> " She breaks the winter of the past;
> A green new earth appears.
> Millions whose life in ice lay fast,
> Have thoughts, and smiles, and tears.
>
> What though there still need effort, strife!
> Though much be still unwon;
> Yet warm it mounts, the hour of life!
> Death's frozen hour is done!"

DISCUSSION.

The CHAIRMAN said he would not detain the meeting except to allude to one particular point on which Mr. Lee-Warner had dwelt, which to him naturally had a great interest, viz., the subject of the administration of justice in India. When he was there some years ago, he devoted a good deal of attention to ascertaining the facts, and to forming an opinion on that particular subject. He did not think there could be any doubt, judging from conversations with many persons capable of forming an opinion, that during the last 50 or 60 years there had been growing up a native judiciary in India, which, on the whole, with occasional exceptions which were sure to occur, were administering justice impartially and uncorruptly. He dwelt very much on that second quality—uncorruptly, because, when one considered the temptation to corruption which existed in the administration of justice; when one looked at the history of European and Western nations in that respect; and, remembering the special qualities which were found not unfrequently in the East, it was a matter of which they must be justly proud that, at the present day, justice was very largely administered in India through native judges, and on the whole that justice was uncorrupt. He would add one criticism on what Mr. Lee-Warner said as to the impression produced on the people of India by the administration of justice. He was not very much struck by the fact that a defeated litigant thought the tribunal was not impartial. That was not confined to India, but prevailed very largely in this country. Judges who were absolutely beyond all possible suspicion were at times regarded, for some inscrutable reason, as having been in a particular case in which a litigant was personally concerned, outrageously partial and unjust. But, although the defeated litigant thought so, it did not follow that that was the general impression. In this country, he would venture to say, there was a firm conviction of the fairness and impartiality with which justice was administered, notwithstanding the unfavourable view of it taken very often by one or other of the parties. The truth was, the confidence you wanted to inspire was in the multitude, any one of whom felt that he might one day or other need to go into a court of justice. He could not help believing that if the people of India had seen that a rich man and a poor man might go into a court of justice opposed to one another, and that the rich man did not always win his case, but that the poor man often came out triumphant, they could not help learning a lesson of the uncorrupt administration of justice, because in a corrupt administration that would be practically an impossibility, and that impression might perhaps be more widely spread than one would be disposed to think. It was, after all, a matter of speculation. No one could ascertain with certainty what the facts were; but he should be more hopeful of confidence in the justice administered spreading itself, if it had not yet spread, among the people than perhaps Mr. Lee-Warner was at present.

Sir STEUART COLVIN BAYLEY, K.C.S.I., said he had not much to say on the subject of the paper, but, as chairman of the Indian Section of the Society, he might congratulate them on the inauguration of the Session by this able and brilliant paper. Mr. Lee-Warner had done great service in calling attention to the amount of work which the Society had done in bringing before the public the various subjects of Indian interest, and popularising knowledge on those points; and he was very grateful to him for recalling those occasional reviews of the moral and material progress of India, of which he gave a brief abstract. He also congratulated Mr. Lee-Warner on having diverged a little from the beaten path, and carried them all to fresh woods and pastures new. To most of them the history of slavery in India was new, and he confessed he was in entire ignorance of the important part played by slavery in that country during the first half of the century. One never found much said about slavery in India, and probably the real explanation of the fact that in all the histories of India Mr. Lee-Warner had only found three lines on the subject was that its importance did not bulk very largely in the opinion of the authors. He was still inclined to think that Mr. Lee-Warner had somewhat overemphasised its importance. He could not go very fully into the subject, but one thing struck him very much. In quoting from an official report, he gave the figures of 60 per cent. of the population in Cuttack, and 33 per cent. in Sylhet as being in slavery, and he should like to ascertain what that slavery really meant. It could not be domestic slavery, because in a purely agricultural district there could not well be 60 per cent. of such slaves. He thought they must be agrestic slaves, or serfs; in some respect *adscriptæ glebæ*, and the question was whether they were not in some way cultivating the soil on their own account. He did not know much about Cuttack, but he was acquainted with Sylhet, which, perhaps, was the most interesting district of the whole of the Lower Provinces. In Mogul times, the district, it was supposed, had been settled by a kind of military colonists put there to guard the frontier against the irruptions of the hill tribes; and during the first half of the century, before the great development of tea cultivation, the population was composed for the most part of Mahometans, which was an important point as bearing on the question of slavery. Another peculiarity was that at the time of the permanent settlement, that was the only district in Bengal in which the settlement was made, not with large landowners, but with the actual cultivators, and the result was that the population was exceedingly well off. There were none of the large divergencies between the very wealthy and the very poor which were found in most districts. They were not a pleasant population, rather rough and turbulent in manner, but well-to-do and exceedingly independent, and probably the most independent in the whole of India. Another point was that whereas in the rest of Bengal when a man got wealthy or lazy the tendency was to subinfeudate and let his land to somebody else, who again let it to another, so that in many districts half a-dozen middlemen were living on the produce of the wretched cultivators below; in that district there was a different tendency, and a much more democratic one; the cultivation was by partnerships, and if one man wanted to live an easy life he did not sublet, but took in an additional partner, so that the ownership extended laterally and not vertically. These conditions were peculiar to Sylhet, and it struck him that they were quite antagonistic to the state of degradation which Mr. Lee-Warner predicated of a district where 33 per cent. of the population were slaves. He thought, therefore, that what was called slavery was something quite different to what was generally understood by that name, or else the degrading influences which Mr. Lee-Warner had attributed to it were in this particular case inoperative. He also doubted very much if the caste system among the slaves was really the outcome of a deliberate scheme of priestcraft, and whether it did not probably grow up naturally in the same way as could be seen at present. When an aboriginal tribe began to be Hindooised, which meant to rise in the social scale, the first thing they did was to adopt Brahmanical prohibitions, then to have a Brahman to perform the ceremonies, then to have a family priest, and finally they developed into a full-blown caste. Probably the same thing would have gone on with the servile population. The paper was full of interesting points, which he should like to discuss if time permitted, but would conclude by proposing a hearty vote of thanks to Mr. Lee-Warner for his interesting and instructive paper.*

Sir ALFRED LYALL, G.C.I.E., K.C.B., said he thought what the reader of the paper had described merely represented what would naturally happen owing to the subjugation of a people really in a mediæval state by a more highly civilised nation. When our institutions came in contact with those of India there was no doubt a change took place which must be very great, but most of the things mentioned had occurred and still occurred among other nations in the same stage. With regard to what had been said about the Brahmans and the degrading rules which were made to restrain the lower castes coming within a certain distance, he believed such rules never had any practical existence. When the English first came to India they wanted to know what the rules were, and went to the Brahmans for information, and they naturally gave the view most favourable to themselves, and very remarkable some of those rules were; but whether they were ever in actual use, or at any rate were strictly and generally enforced, he doubted very much. With regard to the hanging of a Brahman, he quite agreed it was a thing never done by Hindu rulers, and created great prejudice, but his impression was that not very long ago, within a few centuries, in our own country it was very difficult to obtain the execution of a priest for murder. He thoroughly appreciated what Mr. Lee-Warner had said with regard to slavery, and it struck him all the more because it was new to him. He knew the North of India pretty well, and had some acquaintance with the people, but never met with any traces of slavery in the sense usually attributed to the word. Of course, predial slavery existed, as it did all over Europe at one time, and in certain parts recently. He could not realise as a fact that in a country like Northern India, divided into a great many kingdoms, convulsed by wars, and divided by castes, where a slave could easily escape from one country into another, true slavery could ever have existed to the extent represented. There was no doubt that famine created a number of orphans, and there were many children who could not be fed, and doubtless parents sold their children to any one who would keep them when they were not able to provide for themselves. He was not quite certain that he had not even bought children himself; for he well remembered in the Central Provinces some children being brought to him during a famine, and they were distributed among different people, who undertook to support them. Of course, that happened on a large scale in olden times, when no other refuge or resource existed, but that did not appear to him to be anything like what was meant in Europe by ordinary slavery. No doubt the law abolishing slavery was quite right, and hastened the gradual emancipation, which, he believed, would have occurred otherwise. It did not repeal slavery, because there was no law sanctioning it, but it accelerated the emancipation. A man who was reduced to starvation would sell himself to keep alive. As to caste, again, there was no such thing, so far as he knew, in North India as the slave caste. There were very low caste people and outcasts, which was much the same thing in many ways; but he doubted if there were ever in North India domestic slavery of the worst kind; and, he must say, to the credit of India, that he never saw any trace of it.

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* Since the date of the meeting I have had an opportunity of referring to the Report on slavery in India, on which Mr. Lee-Warner has based his narrative, and I am bound to say that it fully bears out all his facts as to the conditions under which slavery existed in India. The Report is exhaustive and very interesting. It was presented to Parliament in 1841, and bears the names of the foremost Indian administrators and legislators of the day. Had I seen it earlier, I should have approached the subject from a different point of view. I may say, however, that the Report explains to some extent the extraordinary phenomenon of this huge institution having been abolished in a day without a ripple of disturbance, without any material change in the social aspect of the country, without attracting the attention of its historians; it shows that slavery was already dying out. The stoppage of slave traffic, and the disapproval of the executive had prepared the way for its abolition, and when the change came, it was accepted as natural and inevitable.—S.C.B.

Mr. C. KRISHNA MENON said he was sorry he could not agree with previous speakers, in thanking Mr. Lee-Warner for his paper; for he must say, at the outset, in dealing with India, its sociology, past history, and present development, one ought to be very careful and avoid extremes. The reader of the paper had taken the most extraordinary views possible with regard to the past history of India just before the British period; and any one not acquainted with the facts would go away with the impression that before the British stepped in India was a seething hell of immorality, vice, and everything that was bad. He must protest against that most strongly, although he was ready to admit the benefits he had received from Western education, and was a humble servant of Her Majesty, although in a subordinate capacity. Where were the traces of the slavery which had been so much spoken of? He came from Malabar, and he knew the facts very well. Mr. Lee-Warner had simply twisted what Mr. Graeme said, when he said the ration given to slaves was less than the famine ration. To say that the food supplied to these "predial slaves" was less than was now doled out in the famine camps was passing over the very basis of fact on which the Famine Commissioners worked. They laid down the minimum living wage for existence, not the average standard of living for workmen. There was no slavery in India at all. He never heard of it. When Megasthenes went to India with Alexander, he said they were a very strange people; they did not take prisoners of war, nor make them slaves. In fact, the treatment of these so-called slaves was far better than that the Hindus at the present day received at the hands of the white people in South Africa, where they were not allowed to walk in the streets with a white man. It must be remembered that the basis of Hindu society was socialistic in its nature, and the first break that society received was the strong modern individualism of Europe, which was not suited to it in many ways. He was neither a socialist nor an individualist, and he admitted that in many ways changes had been for the better, but he could not agree that this break up of many of the wisest institutions of India was all benefit. Sir Thomas Munro, one of the greatest governors of Madras, once said:—"If by a splendid system of irrigation works, a highly developed system of agriculture, and an excellent social organisation, whereby the poor are maintained without a Poor-law, and from the humane nature of the people—if those do not constitute a nation civilised, he did not know what civilisation meant." That was the state of the people of Southern India. To simply take up a fragment here and there, and build up a theory out of it in order to suit one's preconceived notion, was only special pleading, and not viewing the organic development of India as a whole from the earliest period to the present time. The development of India had been one continuous growth in spite of the tremendous shocks it had received in various invasions. The instance given of Coorg, where a large proportion preferred to remain as "slaves" simply showed that it was really not slavery; it was what might be called a patriarchal system, whereby the rich looked after the poor. The caste institutions precluded slavery. So far as the condition of women was concerned, it was nothing like what it was in Europe. To say that women were treated as slaves was simply a calumny on the Hindu race. The grand idea of the "motherhood of God" first grew up in India, and how could it be said that a nation which had such grand ideas treated women as slaves? He was a married man himself, and though his wife was not as educated as an English lady, in the house she was absolute mistress. It was quite common for English people in India to say that the educated natives had no moral courage because they were afraid of their wives. How, then, could it be said that women were treated badly, or like slaves? With regard to Suttee also, a very overdrawn picture had been presented. It was never a fact that every widow was burnt. It was left to her own free will whether to die on her husband's funeral pyre or not, but the moment she decided to do so, she was looked upon as a Divine being. You might condemn the system, as he did, but to say that women were dragged against their will to the funeral pyre was not at all the fact. He would challenge Mr. Lee-Warner to point out any instance quoted by any traveller of such a thing having occurred. The practice arose from a very lofty idea: the wife thought she was part and parcel of the husband, and went to death voluntarily from devotion to him. It was a purely ethical idea. Again, with regard to education, it was said that 260,000,000 people could not read or write, and, therefore, they were put down as an ignorant mass. There was a very great danger in judging education simply by the three R's. The Indian system of education was one of tradition and a wonderful system of memory. He knew a lady, for instance, who could not read or write, but she knew the whole of some of the sacred books; yet such people were put down as ignorant in comparison with an Englishman who reads a newspaper. He knew something about the agricultural population, and had had 300 coolies working under him, of whom only 10 or 12 could read, but they were sober, industrious, and religious, and attached to their families; they were capable of discussing their own affairs, though they did not know anything about Westminster Abbey, the existence of the House of Commons, or the distance between the earth and the moon. All these things had really nothing to do with education. True education was the development of the individual to a higher ideal, and that he got from surrounding influences. The longer he lived, the more he came to the conclusion that the average Hindu peasant was the type of a capable individual. Wherever he went he succeeded; even the Heathen Chinee could not compete with him. He might be superstitious—most people were in a sense—but to call him ignorant because he could not read and write was proceeding on an entirely erroneous notion of what true education meant.

Mr. LEE-WARNER, in reply, said he was sorry that Mr. Krishna had attributed to him such a distorted view of Hindu society. When his critic could read the paper at leisure he would find that the text did not misrepresent the true facts of the case. A lecturer was always obliged to confine himself to one part of a vast subject and to exclude many lights and shades not in his field of view. So far from depreciating the work done in India by Aryans and Brahmans, he gave them exclusive credit for bringing to India civilisation, religion, and law in the distant past. The Brahmans had retained their position through centuries by their education and high intellectual qualities, and they still held the lead by adapting themselves to the new requirements of modern official life. But history showed how bad it was for any caste or oligarchy to maintain and assert its privileges by fashioning religion and law to suit itself, and condemning the masses to ignorance and slavery. With no free press and no free institutions Brahmanism was sure to lack the needed incentive to reform. Now the Aryans from the West had brought back to the Aryans in the East the valuable lessons and qualities which they had learnt in the West, and their brethren who had migrated from the common cradle into India, which had no contact with the outer world, need not be proud or resent the new spirit of laws and administration which the European Aryan had brought to India. Mr. Krishna had disputed several facts stated in the paper, as for example the superiority of the famine diet to the habitual diet of the slaves. If the latest Blue-book on the Indian famine were compared with the voluminous Report of the Commission on Indian slavery, his facts would be found to be strictly true. So too as to Suttee. Numerous instances of enforced sacrifice of women could be cited. In reply to to his other critics, he had already admitted that Indian slavery was mild, and that it varied from province to province. But it was not confined to the household, and the agrarian slaves, in most of the provinces, worked for nothing except their daily feeds. The influence of the Brahmans was of course much reduced in Northern India by the Mahometan rule, but in Western and Southern India, outside the Hyderabad state, it retained to the last much of its original power. The ignorance of the vast mass of the population was an indisputable fact, and the British could take entire credit for the extension of hospitals and dispensaries. When the district headquarters of Kaladghi were moved into Bijapur, a city full of palaces and the capital of a kingdom, there was not one building in the old metropolis which could be used either as a district school or as a dispensary. Several public buildings were vacant, but, owing to sanitary and other objections, they were not fitted for the purpose. This deficiency told its own tale. Mr. Lee-Warner, in conclusion, thanked those who had joined in the discussion for their remarks, and the audience for their kind reception of his paper. In the Chairman's remarks as to the merits of the native judges, he fully concurred, but he doubted whether the public opinion of the masses gave them the credit which they deserved.

As regards the doubts thrown upon his description of slavery, Mr. Lee-Warner has sent the following notice for publication:—I briefly stated, in reply to the criticisms of Sir Alfred Lyall, that I was unable to modify the account which I had given. The discussion had lasted so long, that I was unwilling to abuse the patience of the audience by further remarks. I would, however, invite the attention of the Society of Arts, and those who are interested in the subject, to the following mines of information:—The British statute, 3 and 4 William, 4 chap. 85, s. 88, passed in 1833, required the Governor-General of India to "take into consideration the means of mitigating the state of slavery, and of ameliorating the condition of slaves, and of extinguishing slavery." Evidently Parliament recognised the evils of Indian slavery. The Indian Law Commissioners submitted a report on January 15, 1841. It was printed in the Return to the House of Commons, 262, dated the 26th of April, 1841. The Court of Directors, in their despatch 23, dated October 13, 1841, struck the note of famine relief to which I called attention in my paper, urging upon the Government of India the desirability of providing for the relief of the destitute in seasons of famine, as it was in such seasons that the sale of children usually took place. On July 27, 1842, the Court observed that "all the members of your Government, without exception, concur in the propriety of adopting some measure, whether executive or legislative, for the removal of the evils incidental to slavery." So the Government of India agreed with the Houses of Parliament as to the evils. The Indian Act, passed on April 7, 1843, of which I gave a full *resumé*, affirmed the same view. The Court of Directors in a despatch dated January 31, 1844, stated that the proceedings of the Government of India "have our entire approbation." Other returns laid before Parliament, No. 697, on July 31, 1838, and No. 238, on April 6, 1841, and appendices to the Law Commissioners' Report of 1841, supply further information. As regards the native States, I may, perhaps, invite attention to pages 135 and 294 of my book on "The Protected Princes of India" (Macmillan and Co., 1894), and Indian treaties with Assam, the Punjab Hill States, Faridkote, Kashmir, and Sikkim. The last of these treaties was made in 1861, and in my paper I mentioned a more recent instance in Manipur. My remarks as to compulsory Sutteeism were challenged by Mr. Krishna, but if any one refers to Ward's "History of the Hindus," he will find abundant instances of wholesale murders, and at page 293 of the "Protected Princes of India," I have given a more recent instance of forcible Sutteeism. Finally, as regards the treatment of women, Mr. Krishna appealed to his own experience. But, Sherring in his valuable work on "Hindu Tribes and Castes," explains that "Polyandry is practised by several of the lower Nair tribes," and Aitchison in his account of Travancore shows that "according to Nayar usage the descent is in the female line." The personal experiences of Mr. Krishna Menon may, therefore, be correct, without detracting from the correctness of my general review of the position of women in India.

Sir GEORGE BIRDWOOD writes:—Having vividly in recollection, while listening to Mr. Lee-Warner's able and brilliant paper, Sir Bartle Frere's article on "Slavery" in the *Fortnightly Review* in 1883, nothing astonished me more than the criticisms of some of the speakers who took part in the discussion on the portion of the paper dealing with slavery in India. So far from exaggerating the matter, Mr. Lee-Warner understated it; deriving nearly the whole of his information from the Report of the Commissioners appointed by Lord Ellenborough to frame a Code of Criminal Law for India; on which Report, Act V. of the 7th of April of 1843, abolishing slavery throughout India, was based. Sir Bartle Frere computed the number of slaves in India at the time of the passing of the Act at 9,000,000. But even this was under the mark, the Commissioners having found that, taking one district with another, the number of slaves in India in 1843 amounted from *one-sixth* to *one-half* the entire population. They report that in one district they found over 200 landlords in possession of 2,000 slaves each! But those familiar with the writings of the old travellers in India, and the old writers on the 16th and 17th centuries, well know that down to the time of Akbar slavery was universal in India. He was the first who in India prohibited making slaves of prisoners of war; and before his time not only the captured soldiers were enslaved, but all the inhabitants of captured towns; and we know that this has been the immemorial practice throughout Asia, or, at least, from the date of the "Nineveh Marbles." The Jews were the only Asiatic nation who prohibited slavery by law [Exodus xxi. 16]; but even they adopted it in practice [Matthew xviii. 25]. Hindu law not only sanctions slavery [Manu, iv., 180, 185, 253-6; viii., 66, 70, 365, 415-17; ix., 55], but, after the Hindu manner, creates fifteen categories of slaves. The Mahometan law also recognises slavery. But, down to 1843, not only Hindus and Mahometans in India kept slaves, but the Portuguese, Parsees, Armenians, and English, as was a matter of special notoriety in Calcutta; and I myself recollect, not the formal passing of Lord Ellenborough's Act, but the fact of its passing, and all the domestic talk about Indian slaves and their emancipation in 1843. It is singularly strange, therefore, that two most distinguished Lieutenant-Governors should have, one after another, treated Mr. Lee-Warner's sober statements, in regard to the existence of slaves in India before 1843, as so much moonshine. But it is the psychology of the incident that is so interesting and makes it memorable.

EIGHTH ORDINARY MEETING.

Wednesday, February 3, 1897; the Right Hon. JAMES BRYCE, D.C.L., M.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Page, William, F.S.A., The White House, St. Albans.
Warwick, J. B., Messrs. Mackenzie, Lyall and Co., Calcutta.
Wolfenden, Thomas, 54, Hall-street, Southport.

The following candidates were balloted for and duly elected members of the Society:—

Beach, Thomas W., Ealing-road, Brentford.
Bersey, Walter Charles, 39, Victoria-street, S.W.
Blitz, Rudolf, 74, Leadenhall-street, E.C.
Brown, Arthur George, 38, Victoria-buildings, Manchester.
Cook, Joseph, The Poplars, Codnor-park, Alfreton.
Cox, James A., 44, Old Compton-street, Soho, W.
Grant, Alexander, Maryhill, Inverness.

Hewitt, William, Penn-grove, Aylstone-hill, Hereford.
Jordon, William Leighton, 25, Jermyn-street, S.W.
Mansfield, Edwin Albert, 1, Aldermanbury-buildings, E.C.
Medlicott, John Henry, Office of Chief Engineer for Irrigation, P.W.D., Hyderabad, Deccan, India.
Page, Stanley Hatch, 23, High-street, Maidstone, Kent.
Stinson, Henry Alfred, Belgrave lodge, Mackenzie-road, Beckenham.
Ward, James, Ivy-lane, Macclesfield.

The paper read was—

THE RECESS COMMITTEE: ITS RECOMMENDATIONS FOR THE DEVELOPMENT OF IRELAND'S AGRICULTURAL AND INDUSTRIAL RESOURCES.

By the Right Hon. Horace Plunkett,
M.P., Chairman of the Recess Committee.

I have to thank the learned Association, which I have the honour to address, for giving me my first opportunity of placing before Englishmen certain views upon the Irish question which I hope will not only win English sympathy, but also commend themselves to English common sense. These views first found public expression in the correspondence out of which the Recess Committee grew. In the Report of that body they appear in the form of practical suggestions. If they now stand the test of public criticism, it may not be long before they bring about a new departure in the government of Ireland. I, therefore, approach my task with much anxiety as to the impression which may remain after to-night's debate.

I desire at the outset to dispel a misapprehension which exists in some quarters as to the immediate purpose of the Recess Committee. I have seen it stated in the Press more than once, that this body was initiated to undertake the congenial task of finding opportunities for the expenditure of such moneys as might flow from the labours of the Royal Commission on the financial relations between Great Britain and Ireland. As a matter of fact, our unauthorised committee had agreed upon its recommendations before the famous Blue-book appeared. While we recognise with satisfaction developments which seem to lend timeliness to our labours, I may say on behalf of my colleagues, that we wish our proposals to rest solely on their own merits. We have ventured to put them forward as the best scheme of legislation which, in our opinion, a Unionist Government anxious to advance the material and social prosperity of Ireland, could under existing circumstances adopt.

It will I am sure at once occur to anyone who has the slightest familiarity with Irish life and Irish history that a scheme of practical legislation for Ireland must depend for its chances of realisation quite as much upon its political expediency as upon its economic soundness. Furthermore it is notorious that a bitter past has taught the Irish people to regard with suspicion the motives of every suggestion for their good not emanating from themselves. For these reasons, before discussing the scheme in detail, I propose to state specifically the ideas which gave it birth and the source from which it sprang.

Necessity for Co-operation between the Two Elements of Leadership in Ireland.

The founders of the Recess Committee were under no illusion as to the efficacy of State promotion in industrial concerns. We hold that any scheme for the development of the resources of Ireland must depend for its success primarily upon the efforts of the people themselves. The function of the Government is to supplement these efforts, not to weaken the initiative of the people. We further hold that the proper combination of local effort with State aid, which has yet to be inaugurated in Ireland, cannot be brought about or rendered effective unless the men who are most successful in private enterprise lead the people and advise the Government in the joint promotion of the nation's industrial activities. Unhappily, owing to political conditions, which need not be particularised, not only the leaders of commerce and industry but also the representative men of the classes which have the immense advantage of wealth and education, have long been excluded from all influence upon popular thought and action, and from all active participation in the government of the country. I state emphatically that until our public life admits of the popular leadership of these men in the industrial and commercial enterprise and social development of the people, no real progress can be hoped for and no fruitful attempt can be made to grapple with the problems of Irish poverty.

In saying this I am not casting any reflection upon the actual leaders of the people. Through no fault of their own they are not in a position to take a prominent part in industrial or commercial undertakings. They know well enough what is wrong. They deplore as much as I do the disastrous disunion which deprives them of the assistance which they require to build up the country. But they are pledged to a policy which in their opinion, though not in mine, alone goes to the root of Irish ills. They have taken up this policy from the leaders of former generations, and have pursued it with an ability and fidelity which has secured to them an enormous power over the destinies of a people eminently amenable to the influences of political leadership.

If I have correctly stated the main facts of the situation upon which I am basing my arguments we have in Irish life two indispensable elements of industrial leadership, one monopolising practical knowledge and commercial experience, the other monopolising influence over the people. Is there no means by which these wasted forces can be combined and Ireland be launched upon a new career? That was the question which was before the founders of the Recess Committee, and to that question, the coming together, the working together, and the agreeing together of this body of Irishmen is the threefold reply which I propose to submit for your consideration to-night.

CIRCUMSTANCES UNDER WHICH RECESS COMMITTEE WAS FORMED.

Firstly, then, I will describe the circumstances under which the Committee was formed, and how it was constituted. The election of 1895, whatever the effects it may have upon the great Irish controversy, by universal admission postponed for some years the concession of Home Rule. The situation thus created appeared to offer certain opportunities to Ireland so simple and so obvious, that they were patent to all thinking Irishmen. It remained, however, for one of the least experienced of Irish politicians to put into the form of a concrete proposal what appeared to be in men's minds.

In August of that year, I ventured to send forth in a letter to all the Irish newspapers, what I quite sincerely, if somewhat grandiloquently described as "a proposal affecting the general welfare of Ireland." I submitted that the time had come when there was no longer any reason to spend our energies in actively promoting or in actively opposing Home Rule; that so long as existing political conditions were maintained, the opposing forces might be united for the purpose of promoting such useful legislation as all parties were substantially agreed upon. I instanced two measures which came within this category—a Board of Agriculture for Ireland Bill, and a Technical Education Bill. These measures were practically promised by the Government, and if conceived in the right spirit, and adequately financed, might accomplish much. But, Unionist as I am, I have an innate distrust of the efficacy of remedial measures for Ireland, concocted in England and served up for Irish consumption without any consultation with the patient as to his tastes or his powers of digestion and assimilation. Nor is this distrust in any way diminished by the fact that we have in Ireland at the present moment, in the persons of Lord Cadogan and Mr. Gerald Balfour, a guarantee of statesmanship on a level with the highest traditions of Irish Government.

The definite proposal was, necesarily, so crude, informal, and unconventional, that nothing would ever have allowed it to take practical effect but a state of the public mind such as I have described. Relying upon this I invited the various party leaders each to nominate a few members of Parliament to form the nucleus of a committee. These Parliamentarians were to add to the committee, by unanimous selection, Irishmen representative of the agricultural, commercial, industrial, and professional interests of Ireland, North and South. The committee thus constituted was to meet in the Recess—from this it took its name—then just beginning, and to be prepared before the legislative hatching season commenced to present to our law makers what might be fairly regarded as a well considered, well thought out expression of the nation's requirements.

Such in the rough was the proposal I submitted to the people of Ireland. The details were of minor importance. "It is the principle of the thing," I wrote in the first letter published, "which I want to submit to the sober second thought of my fellow countrymen. I want to elicit an expression of the general desire, which undoubtedly exists, to take advantage of an opportunity for which many of us have too long waited." I added that "we Unionists, without abating one jot of our Unionism, and Nationalists, without abating one jot of their Nationalism, can each show our faith in the cause for which we have fought so bitterly and so long, by sinking our party differences for our country's good and leaving our respective policies for the justification of time."

Mr. Redmond early announced his willingness to give the scheme a trial. Unhappily, Mr. Justin McCarthy, who then led the most numerous section of the Irish Nationalists, did not see his way to take any part in it. Some Unionists favoured it, The outlook so far, did not appear very promising. But, meanwhile, opinion in Ireland was visibly ripening in favour of the project. Public bodies in different parts of the country began to pass resolutions calling upon the Parliamentary leaders to accept the proposal. Finally it was unanimously endorsed by the Corporation of Dublin, the then Lord Mayor offering to put a "Round Table" at the disposal of the committee when formed. This was encouragement enough for the promoters of the new movement. The disadvantage which they suffered from the abstention of the anti-Parnellite members of Parliament was partly compensated for, by the fact that one of the ablest of the Non-Parliamentary members of the Committee was of that party. So we were able to get together a committee which might certainly claim to be thoroughly representative in every material respect. All shades of politics were there—Lords Mayo and Monteagle, Mr. Dane and Sir Thomas Lea (Tories and Liberal Unionists) sitting down beside Mr. John Redmond and his Parliamentary followers. It was found possible in framing proposals fraught with moral, social and educational results to secure the common agreement of the Rev. Dr. Kane, Grand Master of the Belfast Orangemen, and of the eminent Jesuit educationalist, Father Thomas Finlay, of the Royal University. The Chairman of the Financial Relations Commission and one of Her Majesty's Judges were fairly balanced by the present, and two former Nationalist Lord Mayors of Dublin. Sir John Arnott fitly represented the commercial enterprise of the South, while such men as Mr. Thomas Sinclair, Sir William Ewart, Sir Daniel Dixon, Sir James Musgrave and Mr. Thomas Andrews would be universally accepted as the highest authorities upon the needs of the community which has made Ulster famous in the industrial world.

Such was the origin and such the constitution of this strange council. I will now describe their work.

WORK OF THE COMMITTEE.

Quite early in our deliberations the Committee abandoned all idea of promoting Bills. It was seen that such a course would only degrade them into a mere lobbying machine, and their future influence might be damaged by an error in Parliamentary tactics. They decided to address themselves to the task of inquiring into, and reporting upon, the relations which ought to exist between the State and the agricultural, industrial, and commercial interests of the country. It was well known that, in every country which was competing with Ireland in the English markets, the State came to the aid of these interests with lavish expenditure on technical education, and by the dissemination of useful intelligence; that struggling industries were protected and bonussed, the line, in some cases, not being drawn at direct participation in business undertakings. What wonder that our countrymen, who have a traditional belief that the Government is the actual source of all material ills, and the possible source of all material good, should believe that a body of legislators, who really understood these things, could place us on an equality, as producers and manufacturers, with our State-aided competitors abroad. And, be it remembered, the Government had announced their intention to deal with the problem of Ireland's backwardness. If they had been left to produce their industrial development measures in the then existing state of the country's information upon the possibilities of legislation, nothing is more certain than that, however meritorious their proposals, they would have appeared lamentably inadequate, and would only have escaped popular derision by finding refuge in popular apathy and unconcern.

It seemed to the Committee that, in no way could they render a greater service to their country than by helping to create sound public opinion upon the resources of self-help and upon the limits of State interference in the industrial life of the nation. The conclusions at which they might unanimously arrive would then take the form of a moderate and reasonable demand upon the Government. If this demand, based upon the principle, that it is only by the hearty co-operation of the people with the State that any marked or permanent improvement can be made upon the economic condition of a country, should be endorsed by really representative opinion in Ireland, it ought surely to carry weight with our rulers and with the people of England.

INQUIRY ABROAD.

The task we had set before us was a somewhat formidable one. The scope of our inquiry sounded almost boundless. There was no difficulty in agreeing upon the facts, as regards Ireland; but when we came to extend our investigations to other countries, we soon discovered that neither libraries nor official records furnished us with the exact information we required. We had therefore to procure our information in another way. We despatched special Irish Commissioners, who had a thorough knowledge of the conditions to be dealt with at home, to nine European countries whose industrial history and present condition would in our opinion provide us with useful lessons for the economic treatment of Ireland's case. We devoted most attention to those countries which had suffered from an agricultural and industrial depression similar to that through which we are passing to-day, and which are now in a position to compete successfully with us in the English markets. Our commissioners were instructed to inquire into the means by which this change had been brought about, carefully distinguishing as far as possible between the relative effect produced by the efforts of the people themselves and that which might be attributed to the assistance of the State. Mr. Michael Mulhall, the well-known statistician, visited Holland, Belgium, Wurtemburg, Switzerland, Bavaria, Austria, and Hungary. Mr. T. P. Gill whose other services to the Committee both in assisting at its deliberations and in drafting the Report, it is impossible to overestimate, visited France and Denmark. These nine countries form the subject of separate reports in the appendices of the somewhat bulky volume we are here to discuss. To this volume, which contains moreover a special memorandum contributed by M. Tisserand, the Director-General of Agriculture in France, and probably the highest authority on agricultural administration in Europe, I must refer those who wish to see how our commissioners did their work, and to be fully informed upon the facts brought home to the committee. All I can do is to follow the main lines of the actual Report, and to give a brief summary of the evidence before us, and of the conclusions upon which after long deliberations we unanimously agreed.

EFFECT OF PAST ACTION OF THE STATE IN IRELAND.

The first point upon which we had to agree was upon the economic situation with which we had to deal. The Report at the outset presents the following truthful but gloomy picture of our country's condition. "We have in Ireland a poor country, practically without manufactures—except for the linen and shipbuilding of the north, and the brewing and distilling of Dublin—dependent upon agriculture, with its soil imperfectly tilled, its area under cultivation decreasing, and a diminishing population without industrial habits or technical skill." This description being accepted as accurate, the important question arose as to how far we must attribute our industrial shortcomings and commercial disadvantages to what Mr. Gladstone once ironically called our "double dose of original sin," and how far to the commercial restrictions of the last century. The testimony of the historians and economists who have examined the question was conclusive on this point. Repression of every trade and manufacture in which Ireland competed or might compete with English rivals destroyed the spirit of enterprise and the habits of industry. These restrictions have long been removed, but their effects still remained when the awful calamity of the Irish famine took the heart out of the nation and drove what survived of industrial energy to seek an outlet in the Western world. For these reasons, in the opinion of the Committee, special treatment beyond what is needed or would be justified in the case of Scotland or England ought to be applied to the development of the resources of Ireland.

SOME OF IRELAND'S AVAILABLE RESOURCES.

This brings us to the question—What are the available resources of Ireland, agricultural and industrial, and what are the possibilities of their development? Clearly agriculture was the industry to which we must direct our first and chief attention. "Ours is," so runs the Report, "by common consent one of the simplest and most barbarous systems of agriculture in Western Europe, both as regards the want of variety in the crops and the scantiness of the produce."

Ample evidence was adduced of the miserably low yield of the various crops, Sir Robert Kane, an eminent authority, estimating in his evidence before the Eardley Wilmot Select Committee, that with improved methods of husbandry the soil of Ireland might treble its produce, and by a scientific system of mixed farming, the land might carry three times its present number of live stock. Irish butter, twenty years ago, was the best in the English markets. To-day, it has been left far behind by methods of production which Ireland has only just begun to imitate. One would have thought that at least we could have catered for the Englishman's unfailing demand for bacon and eggs at his morning meal. But in both commodities we are worsted by the foreign supplier. Lord Dufferin, when he gave his weighty support to our recommendations in the public meeting at Belfast, made a happy reference to this unhappy circumstance. "All Ireland," he said, "ought to blush at the thought that she cannot produce a pig—an animal which from time immemorial we have been accustomed to regard as a member of our family circle—which can dare to show its face in the British or European market in the presence of a Danish pig. I would ask what are to become of our industries and the glories of Clontarf if our Irish pigs are to submit to these indignities at the hands of Danish swine? Then we import nearly £4,000,000 of foreign eggs. What, then, becomes of our Irish eggs? Are they only fit to be reserved for our lively election purposes?"

It is generally conceded by experts that an immense waste might be saved by a more humane system of shipping cattle. The loss from unnecessary injury in transit is estimated by the Irish Cattle Traders' Association at nearly £1,000,000 sterling. Some think that improved systems of refrigeration now admit of a dead meat trade being substituted for the present shipment of fat cattle alive. If this is so, not only will the loss above referred to be saved, but there is no reason why the diversified industries subsidiary to the slaughter of cattle—the manufacture for instance of leather and bone, glue and artificial manures—many of which once flourished in Ireland, should not be restored. My own opinion is that such a development must wait a higher degree of technical education, and a much greater familiarity with methods of industrial combination than now exists in Ireland.

I have little doubt that, with further improved means of communication which are being established in Ireland, the genial climate of some portions of the south and west would afford opportunities for profitable market gardening, especially in early vegetables.

Coming to what may be classified as industrial crops, namely, beetroot, tobacco, and flax, each has its supporters among men whose opinion must carry weight. The late Professor Sullivan, President of Queen's College, Cork, probably the highest authority on Ireland's agricultural and industrial resources the century has produced, was a firm believer in the suitability of the soil of Ireland for the cultivation of the sugar beet. Personally, I should fear the saccharine properties of the Irish root would be impaired by want of sunshine. Moreover, the industry could not be started, in face of the extravagant protection by which it is fostered abroad. But Professor Sullivan's opinion is a weighty one; and his reason for his warm advocacy of the introduction of the manufacture into Ireland make the development of this industry worthy of the most careful consideration. It would mean, he pointed out, intense cultivation, and large employment for men, women, and children in the field, with a most beneficial educational effect on all other kinds of agriculture. He attached especial value to the chemical and mechanical operations involved as they open up a career for large numbers of chemists, engineers, and skilled mechanics. And one possibility referred to especially came home to me. The industry he surmised "might also teach the Irish farmers the value of co-operation, upon the adoption of which I believe the future prosperity of Irish agriculture—nay its very existence, depends."

As to tobacco I am informed it can be grown in Ireland, but whether we have Irishmen with patriotism enough to smoke it I am not smoker enough to decide.

Flax is by far the most important of the industrial crops. Scientifically cultivated and prepared it is a most remunerative crop to the farmer. But, in spite of this fact, the import into Ireland of foreign flax is rapidly increasing and the area under cultivation correspondingly decreasing. The average prices of home grown and Belgian flax are £38 and £52 per ton respectively. And coincidently with the decrease of flax growing, the linen trade itself shows symptoms of decline. The imports of both linen and linen yarn into the United Kingdom are on the increase and the exports are decreasing. On the Belfast branch of the committee the linen trade was strongly represented, and we may safely accept their opinion that the decline of the industry is mainly due to the superior technical education afforded to our continental competitors, and that, in order to compete with the foreigner on even terms, this obvious remedy must be applied at home, more especially at the farmer's end of the industry.

Among other resources of the country to which prominence is given in the Report, are forestry and the reclamation of waste land. The subject is so wide that I cannot attempt to discuss it now. We came to the conclusion that a large scheme of reafforestation, properly devised and carried out, would prove to be a sound if—to use a convenient Americanism—a somewhat long-winded investment. While waiting for the marketable timber, there seems to be a prospect of a fair return from such products as bark, charcoal, resin, pitch, tar, and turpentine, as well as from the various wood-working industries, including wicker-work. And in addition we are told by meteorologists that the country would derive considerable climatic advantage from a large and well considered scheme of reafforestation and reclamation.

Of the fisheries, it is safe to say that only an infinitesimal share of the wealth which surrounds our coasts goes to enrich our countrymen. But it is an encouraging fact that, among that portion of the population which is least advanced in civilisation, the Congested Districts Board has shown that a trade both in fresh and in cured fish can be developed and placed upon what appears to be a permanent footing. That much in this direction could be done all round the coast without any departure from sound economy, is the opinion of the Recess Committee. It may be added that the inland fisheries are capable of similar development.

Then there is the whole range of what are known as "Cottage Industries," which we believe a really sound system of technical education could create or restore to a peasantry by no means devoid of artistic sense. By the same aid I believe the once famous woollen industry of Ireland might struggle again into life.

The Report deals with some other vanished manufactures, such as paper-making and glass-making, which may some day be restored. But on these speculations I need not further prolong this very rough survey of the immediate and remote possibilities of industrial Ireland.

Such appeared to us to be the available resources of our country when our commissioners sent in their reports upon the promotion of agriculture. It would not be possible, within the limits of this paper, to describe, except in the broadest outline, the methods by which our competitors in the industrial race have been enabled to succeed where we have failed.

METHODS OF PROMOTING AGRICULTURE ABROAD.

Let us first consider the methods of promoting agriculture. The circumstances of the countries from which we gathered our information present a great variety of economic conditions. There were countries like Denmark purely agricultural, and others like France, Bavaria, and Austria, where manufactures play an important part. There are small countries like Switzerland and Wurtemburg which have been purely agricultural and are now largely industrial. Denmark competes directly with us in our staple products of butter and bacon; some countries in the various milk products, and others in linen and linen yarns. In all, industries allied to agriculture are prosperously carried on.

Various as are the conditions of the countries under review, we soon discovered three main principles in promoting agriculture common to all. They may be summed up in the words *Organisation*, *Representation* and *Education.*

The Organisation of the farming classes takes the form of what we understand as farming societies which have been spread throughout every district in these countries, and are generally bonded together by a system of provincial and national federation. Many of these societies are co-operative trading bodies, and these appear to be most valuable not only in their economic, but also in their industrial and moral, effect. The Government invariably recognises the paramount importance of these organisations, in some instances creating them by legislative enactment. It fosters their promotion by information, education, and advice, and by direct subvention as well when they are not trading bodies. And, whether trading societies or not, the central department always relies on voluntary association as an indispensable agency in the local administration of State aid.

The second principle, Representation, needs no support in argument. It is obvious that a Government which has learnt to work with and through the people in the promotion of agriculture must appreciate the value of being in touch with and representative of popular opinion. Effective and regular representation is secured by a Consultative Council, which we have imported into our scheme. This body, which exists in all the countries we visited (with the exception of Denmark, where organisation is so general and complete that the societies are entrusted with the administration of State aid, and of Hungary, where the farmers are clamouring for the institution), is usually two-thirds elective and one-third nominated. There is a responsible Minister at the head of the Department, and he is bound to consult the Council before introducing important legislative proposals, though he need not take their advice.

AGRICULTURAL EDUCATION ABROAD.

The remaining principle, Education, as a means of advancing the farming industry is everywhere accepted almost as universally as it is disregarded in Ireland. So we have only to further emphasise its importance and point out one or two main features of the Continental systems which we have adopted in our recommendations. In every country where we prosecuted our inquiries we were assured that education was the great secret of success. In 1860, the British Vice-Consul at Copenhagen described Danish butter as "execrably bad." The development of this great national industry is directly traceable to education. The head of the Dutch Board of Agriculture and Industry says: "Every guilder spent in the promotion of agricultural teaching brings back a profit hundredfold." The Belgian Minister of Agriculture, in his message to Parliament last year, said that every franc so spent "brings a brilliant return." As to the means of providing agricultural education in connection with the elementary, secondary, and higher systems in the various countries, and in special agricultural schools, there is no need to speak. The well-known institutions of "example plots," and "experimental stations," are to be found everywhere. "Most countries, moreover," to quote the Report, "have adopted a system of travelling instructors or professors, who not only superintend the agricultural courses given in the primary schools of their districts, but also hold conferences and give lectures, and advise, and keep themselves closely in touch with the actual cultivators of the land. Agricultural schools for the farmers' daughters, in which they are taught what is called in France the 'lore of the farmyard and farmhouse' including the rearing of poultry, the feeding and tending of live stock, cooking, domestic economy, and the keeping of farm accounts, are also to be found now in most of these countries." In all this work, the foreign Governments invariably call into play in the support and management of the schools, local contribution, supervision, and responsibility. Another common feature in agricultural education abroad is that the utmost elasticity of curriculum is allowed in order to meet the requirements of each locality.

METHOD OF PROMOTING INDUSTRIES ABROAD.

Coming to the promotion of industries, we find State assistance in forms which it cannot assume—at present, at any rate—in these countries. But leaving aside all those measures of artificial support which are incompatible with a policy of free trade, there is a wide field of State assistance which only offends against the moribund doctrine of *laissez faire*. Here we meet again with the three principles of Organisation, Representation, and Education which we found to be the guiding principle of State assistance to agriculture. The single instance of Würtemburg will almost suffice to illustrate the working of these principles.

This little State was, forty years ago, purely agricultural and over-populated. To-day England buys from Würtemburg the following strange miscellany:—Blankets, carpets, hosiery, flannels, linens, tissues, instruments, types, rugs, chemicals, paper, ivory goods, wood carving, toys, furniture, hats, pianos, gunpowder, clocks, stays, and repeating rifles. This is not bad for a population forty years ago devoid of mechanical knowledge. Nor has agriculture suffered by these new developments. On the contrary it prospers through the growth of the town and village populations. Mr. Mulhall was assured that there is not a pauper in the kingdom of Wurtemburg.

It seems that this extraordinary revolution was brought about not by a Recess Committee but by a single man—the illustrious Dr. Von Steinbeis. Carrying home from the London Exhibition of 1851 a knowledge of the handicrafts of the nations of the world, he persuaded the King to allow him to found in connection with the Ministry of Commerce a Board of Industry under his own presidency. The Board, or Central Stelle, as it is called, is assisted by a consultative council, composed of teachers in various institutions, and merchants and manufacturers elected by Chambers of Commerce. "The Central Stelle," says the report, "takes care, while encouraging private enterprise, never to supersede it. It gives advice; it advances money for the establishment of industries; it introduces schools for the teaching of trades; it sometimes starts industries itself, but always on lines which eventually lead to the absorption of these industries by private enterprise, in the form of companies or associations. It keeps in close touch with the trade organisations of the country, with the merchants, and manufacturers, and with the municipalities and local authorities; and in the schools which it establishes it throws the responsibility of management upon local committees, and requires that the localities shall contribute to their support in proportion to the Government grants. A guiding principle of its action is that more is to be gained by practical assistance in the development of industry than by theoretical instruction. In teaching a handicraft it has always been careful to promote an industry in the locality, and to find it a market. It has managed to introduce industries into given localities by sending skilled workmen abroad to acquire a knowledge of new methods in trade and agriculture, who, on their return, go about to towns and villages giving instruction, and by introducing foreign workmen and instructors."

TECHNICAL EDUCATION ABROAD.

The educational course adopted appears to be absolutely justified by the results. A remarkable piece of evidence in proof of this has been furnished within the last couple of weeks. I refer to the report of Sir Philip Magnus and three other members of the Royal Commission on Technical Instruction, who visited Germany within the past few months and found everywhere increasing expenditure on technical education and increased belief that technical education is the chief lever of the immense industrial progress achieved by Germany in recent years.

APPLICATION TO IRELAND. — FIRST PRINCIPLE—ORGANISATION.

The Committee next had to apply the teaching of foreign countries to the special circumstances of Ireland. We found it convenient to discuss separately the question how far the State may go in the direct promotion of agriculture and industries respectively, and what they can do in the way of technical education or as the committee, adopting French terminology preferred to call it—Practical Education.

Taking agriculture first, we were quite unanimous as to the necessity of founding our scheme upon those three fundamental principles—I am almost ashamed to enumerate them again—*Organisation*, *Representation*, and *Education*.

So urgent, in the light of foreign experience, does the need of complete and thorough organisation of the Irish farmers appear to us to be, both from an educational, industrial, and moral point of view, that I quote the passage from the Report in which we summed up its advantages:—"It is the most efficient means for spreading enlightened and new ideas amongst the farmers. By combination, and by meeting together to exchange views, they are enabled to grasp in the shortest time, and make the quickest use of all information supplied them through the agency of the State or otherwise; they are able to apply by combination, resources of capital and skill to their industry which would be beyond their reach as individuals; and, finally their spirit of self-reliance and mutual goodwill is preserved, and they are saved from the error of relying too much upon the State and too little upon themselves and their neighbours."

Unfortunately, organisation of the kind required to fulfil these conditions is not as yet sufficiently understood or appreciated in Ireland. The Royal Dublin Society covers a large and varied field of usefulness; but it lacks any proper representative element, and is not, therefore, sufficiently in touch with the working farmers of the country to promote that combination of local effort and State aid which, in the view of the Recess Committee, is the condition precedent of real agricultural progress. There are in Ireland a certain number of farming societies, which, to quote the Report, "sometimes get up cattle shows, and make other efforts at stimulating agriculture; but," the committee had to admit, "they have no common bond; and, acting in isolation, and without any State contribution, they necessarily make but a very feeble impression upon the great industry whose interests they seek to promote."

THE AGRICULTURAL ORGANISATION MOVEMENT IN IRELAND.

There is, however, a new movement on foot in Ireland which is destined to play so important a part in the initiation and organisation of self-help that I must give a short description of it. It was inaugurated some seven years ago by a few Irishmen who discerned the absolute necessity of agricultural organisation for the salvation of Irish agriculture. They laboured hard and long before this economic doctrine was accepted by the farmers. They had of course to encounter the natural suspicion of the people as to the motives underlying their advocacy of economic reform. But the only really formidable difficulty to be overcome was the want of confidence of the farmers in each other, and, worse still, in themselves. Indeed the idea that Irish farmers could combine for quiet business purposes without any political incentive was hardly listened to with patience. The Irish can conspire, it was said, but they cannot combine. Our agricultural reformers, however, took little account of the scepticism of superior persons. They occasionally met with encouragement in unexpected quarters, which cheered them on their way. I recollect one chilly autumn morning, in the first years of the movement, setting out from Limerick in a little steamer which was to take us down the Shannon to a spot where an attempt was to be made to organise a Co-operative Dairying Society. I got into conversation with a fellow passenger, who made me explain to him the purport of my mission. To my great delight my unknown steamer acquaintance not only grasped the whole conception of our work, but expressed entire sympathy with the endeavour and his confidence in its ultimate success. My steamer acquaintance was the distinguished statesman, historian, jurist, and economist who now occupies the chair. Well, Mr. Bryce's forecast has been verified. Our progress was slow for years. But by 1894 the little farmers' combinations, the fruits of our labours, were growing so fast that it became necessary to found a society to carry on the work. The project was generously supported by men as widely representative as the members of the Recess Committee. The Irish Agricultural Organisation Society has to-day under its wing, and mostly affiliated with it, some 130 co-operative farmers' societies with some 13,000 members, all organised on Continental patterns—self-supporting, thoroughly democratic, commercially sound, and manifestly permanent. They have applied the principles and practice of industrial combination to dairying, to joint purchase of agricultural requirements, joint sale of farm produce and live stock, the better cultivation of flax, co-operative credit, and many other purposes connected with their industry; and, what is most encouraging to advocates of organised self-help, so fully have their principles been accepted by the Irish farmers, that the Organisation Society's office is besieged with invitations from bodies of farmers all over Ireland, who are anxious to combine, but do not understand the constitution and procedure required to make combination permanent and effective. The economic value to the country of such a development is so little understood, that the Organisation Society is just now stranded for want of funds. To provide fuel for so powerful an engine of industrial progress presents an opportunity to any wealthy lovers of Ireland of exercising the highest, and most direct and fruitful influence in raising the social and economic conditions of the people.

It was strongly urged by the *Times*, and the *Spectator*, to some extent, agreed, that we have not in Ireland, and cannot generate, that local effort which, on our own hypothesis, must at least accompany, if it does not precede, any really economic and effectual assistance from the State. I have, therefore, thought it important to show that, in the light of what our farmers have already achieved in this direction, the State cannot withhold a generous policy of industrial development in Ireland, on the ground that the people are not ready to receive it, and to turn it to the best account.

AGRICULTURAL EDUCATION FOR IRELAND.

Our recommendations as to the manner in which such assistance should be given follow the lines of the most fruitful educational methods of the Continent, and need not be set out in detail. Example plots, experiment stations, statistics, laboratories, one or more agricultural colleges, are all included in the scheme. Perhaps the most immediately beneficial of our proposals is that a staff of travelling instructors, capable of diffusing information upon cultivation and the relation of science to agriculture amongst the farming classes, should be instituted. They would conduct conferences and lectures for farmers, advise upon the management of holdings, superintend and assist in the agricultural course in primary schools, and direct the cultivation of example plots. The committee also propose that the scheme should be translated into the female gender, and that instructresses should organise women's conferences, and promote efficiency in housekeeping, dairying, bee-keeping, and poultry management.

It is a strange and little-known fact that this system of education was actually initiated by the Irish National Board of Education as far back as 1838. It succeeded well during its brief existence; but it encountered fierce hostility from the English free traders, and was buried, I hope, to be disinterred by the present Government after half-a-century of *laissez faire*.

PROMOTION OF INDUSTRIES IN IRELAND

I shall pass by the actual recommendations of the Committee, both as regards the direct promotion of industries and the establishment of a system of practical education in relation thereto. I have preferred to indicate the general principles followed in these matters and the sources from which they were derived. With regard to the former function of the State, we felt strongly that the time had come for a declaration of principles applicable to the case of Ireland. We ought to make up our minds as to how far we may copy the methods of other nations? Fiscal protection we know we cannot have. But will it be maintained that in view of the historical circumstances to which I have referred, the State may not justifiably assist in the initiation of industries and even find and cultivate markets for their out-put? We do it in the Congested Districts Board whenever we see a chance of starting an industry in, say Donegal homespuns or West Coast fish. It could easily be shown, too, that the Government is doing this very thing every day with its reproductive loans, its Consular service, its piers and harbours, light railways, and in many other ways. We lay it down that where private enterprise cannot develop industries the State may create a condition of things where the former shall be able to do so.

Upon the details of our Practical Education proposals I must exercise the same reserve. I will only say that the Recess Committee have sought by their suggestions to combat the tendency to regard every profession but that of a clergyman, a lawyer, or a doctor as beneath the dignity of a well-born man, and every occupation but that of a clerk unworthy of the social ambition of those who can escape the necessity of day labour. In short they seek to elevate to the rank of an honourable profession the callings of commerce, agriculture, and manufacture.

THE LEGISLATION PROPOSED—A MINISTER OF AGRICULTURE AND INDUSTRIES FOR IRELAND.

It now only remains to sketch the outline of legislation which we have presented to the Government. If the Committee have justified their faith in the resources of the country and the resources of the people, it will be evident that some new machinery will be required to inaugurate what I repeat is a policy of co-operation between the people and the State.

We propose that a Ministry of Agriculture and Industries should be created, consisting of a Board with a Minister responsible to Parliament at its head, and advised by a Consultative Council, partly elected, partly nominated. The Board should consist of at least five members, as far as possible representatives of the different political parties, but, above all, practical men in touch with the agricultural and industrial life of the country.

HEAD OF BOARD RESPONSIBLE TO PARLIAMENT.

Such a Department as is contemplated, with its new and important functions, should certainly have a head responsible to Parliament. At present the work proposed to be transferred to the new body is entrusted to a large number of departments, none of them directly represented in Parliament. The Chief Secretary, in addition to his administrative functions and executive responsibilities, has to answer for the whole congeries of departments. This system while over-burdening the Chief Secretary's office, does not admit of satisfactory responsibility to the representatives of the people, and is one of the chief reasons for the chronic dissatisfaction in Ireland at what is called "Castle government." To add new functions to the Chief Secretary's office would only intensify the evil, and absolutely negative the first principles of the new departure upon the necessity of which we so unanimously agreed.

A CONSULTATIVE COUNCIL.

While the representative Board with its truly responsible and untrammelled head are intended to engender public confidence in the work to be undertaken, the Consultative Council is designed to bring the Department into direct touch with the classes it is to help, and with the interests it is to subserve. Its functions are purely advisory, but its salutary influence upon the central government is abundantly manifest wherever it exists abroad. It would be in its nature a sort of national Chamber of Agriculture and Industries.

A DEMAND EMANATING FROM ALL CLASSES IN IRELAND.

These recommendations, then, are the outcome of a united effort on the part of men of the most divergent religious and political convictions, of men representative alike of the commerce and industries of Ulster, and of the agricultural interests of the whole of Ireland. The Queen's Speech, in promising a Board of Agriculture for Ireland, practically cuts down our proposal by one half. I think it is a mistake. But my Ulster and Irish commercial friends generally, while they express their disappointment, are ready to admit that half a loaf is better than no bread. They say, however, that the bread of the remaining half must be good. The fundamental principles, by which alone the co-operation of the people can be secured, must be observed. We have asked for State aid. But, unless this can be given in a way that will engender self-reliance, it would be better for poor Ireland to dwell in her necessity until her case is understood. I hope, however, that we may successfully appeal, not only to England's sense of justice, but to her enlightened self-interest. I have carefully abstained from basing our claim upon the financial grievance. Apart from any such case, it is for the advantage of the United Kingdom to add to the material prosperity, or shall I say, to the taxable capacity, of its more backward parts. Our scheme has already commended itself to British public opinion, if the British press is any guide. What, then, is to hinder the Government from seizing the golden opportunity, when they can at last legislate in accordance with a popular demand for Ireland, which is in no way prejudicial to the interests of that Union which they are pledged to maintain.

DISCUSSION.

The CHAIRMAN said this paper was not only lucid but suggestive, and furnished material for a much longer discussion than could take place that evening. In the first place, he would advise those who had not already done so, to read the full Report of the Recess Committee, which contained a great deal of valuable matter, and was so well written as to give great pleasure in its perusal. It was a very rare, but a very pleasant, thing to be asked to speak on Ireland, without dealing with politics, for most Irish discussions either began or ended with politics; here was a clear and temperate document concurred in by persons of the most opposite political opinions, but who all united in desiring the material and social wellbeing of their country. There might be different views as to the probable success of this movement. Some might think it would assuage the discontent of the Irish people, and would be accepted by them in place of those wider measures which they desired. On the other hand, it might be thought that the material development of the country would remove many of the objections which had been felt on this side to the conception of that scheme of self-government, and would, in some respects, make the need greater for well-considered legislation tending to develop the material resources of the country. But it was not necessary to examine further either of those views. Whatever political consequences might follow this movement, it was *primâ facie* entitled to sympathy and support, and would no doubt be welcomed in both countries. The reasons given by the Committee for believing that great industrial and agricultural progress might be made were so complete as almost to suggest surprise that the country should at present be in so backward a condition. One was inclined to ask, if Ireland possessed these wonderful agricultural opportunities and these capacities for industrial progress, why was it that capital had not flowed there, and why had not such a confessedly gifted people developed their resources more. The answer of the Committee was that more than 100 years ago Ireland was developing when the mistaken and selfish legislation of England stripped her and threw her people back on agriculture as their only employment, and in so doing not only checked the industrial progress she had already made, but destroyed the mental habits her people had begun to form. That was an answer which those who had studied Irish history would be disposed to think was complete, and that was one of the strongest reasons why England and Scotland should now feel bound to do even more than they otherwise would to atone for their former mistakes. The Report had not stated at all too strongly the agricultural position. It showed a soil singularly well fitted for one of the most promising industries, the rearing of cattle, and the growth of dairy produce, as well as as for various other crops, notably flax. But cattle and dairy products were the most important because of the unlimited market for them in the large manufacturing communities of Great Britain. There was the unusual conjunction of a country where wages were low and living cheap, fitted for this kind of production, and an inexhaustible market close at hand. The practical proposals of the Committee had only been sketched in outline, and to get a full grasp of their importance, the full Report should be studied. That contained in some of the reports from foreign countries, instances of the practical forms which these proposals might take. The suggestions were, mainly, three. First, a Board of Agriculture for Ireland, and the Government had given notice of a Bill for that purpose. Secondly, that State aid should be given to develop industries in the way pointed out. Mr. Plunkett went a little further than some would be inclined to follow him, in talking of the doctrine of *laissez faire* as moribund. He (the Chairman) confessed to a belief that that doctrine was overstated by the great economists of the last generation, and by one eminent man who still continued to fill his books and the newspapers with his lamentations on this subject; but at the same time they must feel that there were certain truths embodied in the doctrine which must not be forgotten. He should be sorry to think that in endeavouring to develop Irish industries they were going to forget the necessary safeguards and incidental dangers against which economists of the *laissez faire* type had warned them. Mr. Plunkett would say and truly, that the State had already tried to do a good deal in Ireland to develop agriculture and industry, and he would also say that it had generally failed. It had spent an immense amount of money, and experience had shown that great care and caution were needed how they should proceed in future. One of the capital faults had been, not only that the money had been expended in a haphazard way instead of on fixed and wise lines, but also that it had been given to meet some casual and transitory demand on the part of some particular section of the people or their representatives. Three-fourths of the money which had gone to Ireland had been wasted, and he believed it was largely due to the fact that it had not been spent on any wide scheme, but simply to stop clamour by a temporary dole. And those dangers were not over, and could not be under a Government such as ours. The example of Wurtemburg had been cited, where the Central Stelle did so much to develop agricultural industry; and that evidence was highly suggestive, but, it must be remembered, that a German Government department was very different from an English one. In Germany there was a thoroughly bureaucratic system, and very little interference by the representatives of the people. The department formed its own plans, after taking highly scientific advice; and when it had made up its mind what to do, did not regard local clamour. That was not the case with the British Parliament; and anyone who knew the way in which Parliamentary business had to be carried on, especially in Irish matters, would feel that the very greatest care was needed in bestowing public money for the promotion of agriculture or manufactures in Ireland. Whatever was done by the State ought to be done under two conditions, both of which were dwelt upon by the Committee. One was, that the State should aim, not at superseding, but stimulating private enterprise; and the second was, that whatever was done should be done, not by the central authority in Dublin, but, as far as possible, by a popular body. It was suggested that there should be a Minister of Agriculture, assisted by an advising Board, to be nominated by the Government, and secondly by a large consultative council. In the third place he understood the idea to be that in the various localities there should be, as far as possible, a popular element associated everywhere with the local executive which had to carry out the general scheme, and that local bodies should be formed in whose hands to some extent the distribution of the money should be placed; and that these bodies should include as much as possible local experience and knowledge, and should inspire local confidence. Anyone who knew the great difficulties hitherto encountered in Ireland would feel that a scheme of this kind would double its chances of success if it enlisted the co-operation of the people themselves, so that they might feel it to be their own work, not something imposed upon them from Dublin. The third suggestion was that special efforts should be made to develop technical or practical education. While entirely agreeing in the great value of technical education, and feeling how strong was that point, he hoped it would be remembered that all technical education must be accompanied by two things: First, there must be an endeavour to raise the general level of education, elementary and secondary, so that the young people's minds might be more alert, and more fitted to take advantage of the special scientific and practical instruction given them. It was not merely the technical education of Wurtemburg, Switzerland, and Holland, which had been so beneficial, but the high level of education in their elementary and secondary schools. This was above all true of Switzerland, where primary education cost more in proportion to the wealth of the people than in any other country, and where it was carried to a higher point than anywhere else. In the second place, the technical education needed in Ireland was not only the practical instruction given in schools, but the highest scientific training in colleges. In that way they would not only be producing a class of competent teachers, but men fit to take command of industries and carry on the work of scientific discovery, and direct those who profited by the simpler kinds of instruction. That again was a marked feature in the system of our continental rivals. What had recently appeared on the subject of technical instruction in Germany showed what importance was attached to having large high class finishing institutions for giving the highest class of scientific education to those who were going to engage in practical scientific work. Lastly he would say that they must not form exaggerated hopes as to the time in which Mr. Plunkett's objects would be accomplished. The habits which were checked in the last generation were not easily re-cultivated, and it would probably take two or three generations before all that was desired could be attained. There were, however, two great grounds for encouragement. One was the undoubtedly quick, keen, intelligence of the Irish people, and not only that but their great desire for knowledge; the natural fondness for learning was probably greater in the Celtic than in the Teutonic race. In the next place there was the experience already gained in connection with co-operative societies. No part of the paper was more interesting than the way in which they were told of the results already attained in that direction, which were valuable not merely on account of their material success, but still more so from the mental habits which must have been formed. England and Scotland owed a deep debt to Ireland, not merely the pecuniary debt to which the Royal Commission referred, but a much greater debt, to atone for the faulty legislation of the past, and to endeavour to give back to Ireland what she would have had, had it not been for the mistakes committed in darker times, and to show that they were anxious to give her every opportunity of taking her place in prosperity and social and moral well-being, by the side of more favoured countries.

The Right Hon. **Evelyn Ashley** said he could speak from personal experience of the great benefits which co-operation had already conferred on Ireland. He had a residence in the wilds of Connaught, in a congested district; and, already, he had seen springing up co-operative societies, which were doing a deal of good. As the Chairman had said, the great defect in Ireland was the want of general education; without which, as a groundwork, technical instruction would be useless. The Irish were above the same class in England in intelligence, but there was no compulsory education there, and that was the first necessity, because, although there were a great number of schools and schoolmasters, there was no power of making the children attend; and fitful education was no education at all. In his own district he would undertake to say that not more than half the population could read or write. It was very delightful to see Irishmen combining in this practical way and showing their knowledge of Irish character. That character was in many respects better than the English, and in many respects worse, but in every respect it was different. When he first took up his residence in Ireland, 25 years ago, he had a lot of English notions about improving the people, but he soon found how little he knew about it, and how suspicious the people were of him, and he soon had to start entirely afresh. In fact that was the only argument for Home Rule, that the English people did not know the Irish character, and did not understand how to govern the Irish. One of the great defects of the Irish character was an inordinate suspicion of everybody who was placed in authority, and the tendency to attribute motives which did not exist. It was, therefore, absolutely right to insist as the basis of this movement that everything should be managed by the people themselves. There was a creamery established near him by a gentleman of good disposition and large means, who wanted to do the thing in a high-handed manner, but though he spent a great deal of money to get the best machinery after a year or two the whole thing collapsed, and was now a beautiful glazed monument to the man's ignorance of the Irish character. Two or three years after, another creamery was started by some residents who understood the Irish character, and who began by insisting that every farmer who sent his milk should take at least one share in the concern; that had been a great success, and promised to be of great benefit to the neighbourhood. Twenty years ago Sligo butter market was one of the first in the kingdom, and sent large quantities to England at good prices, but it had gradually declined, until the heads of the trade became very much alarmed. The reason was simply that, owing to the introduction of first-rate butters from abroad, buyers would not have what they called streaky casks, viz., those which were filled day after day with successive layers; but, in a co-operative creamery this difficulty was avoided, and a homogeneous article was put upon the market. The prospects of industry in Ireland were at present better than they had ever been, and it was therefore an opportune moment to begin. There had been a hopeful discontent infused into the people, who, up to the last ten or fifteen years, had been perfectly content with their lot; but now it was not so, they wanted to rise. The tenants had fixity of tenure, and were ready to embrace any opportunity which was offered them. The English people were not asked for money, but to assist in passing the measures which Ireland desired, and for which a good case had been made out; and he hoped every one would do what he could to forward a movement which, he believed, if carried out, would alter the whole aspect of Ireland.

Dr. **Rentoul**, M.P., Q.C., as representing an Irish agricultural constituency said the universal feeling was, that whatever might be the outcome, Mr. Plunkett had done a good thing in bringing this Committee together. If he were joined by his political opponents in this work, he had proved that Irishmen were capable of co-operating for the benefit o their country apart from their political differences, and if, on the other hand, the members of the other parties would not join with him and his friends, he had at least done something for his own party by showing that they, at any rate, were willing to do their best. The previous speaker had referred to the necessity for general education as preliminary to technical instruction, and advocated compulsion, but the difficulty about that was that it raised the whole question of denominational education, and that rendered compulsion at present impossible. The difficulty which struck him about the matter was this. He feared that agriculture could not be carried on profitably over a large portion of the country, but only at a loss, and, therefore, he was more in sympathy with that portion of the scheme which referred to other industries. There were five or six industries in Ireland which were second to none in England, or, perhaps, in Europe, but if Englishmen could not make farming pay—and he did not believe it was paying generally in England at present—still less could Irishmen. In England there were only 11 per cent. of the population engaged directly in agriculture, but in Ireland there were 60 per cent. Consequently, what he looked to most was a strong, broad attempt on the part of the Government to foster manufacturing industries, and the sooner a step of that kind was taken, the better it would be for the country. He did not believe Ireland would ever take a good position so long as agriculture was her main industry. They must try to remedy the wrongs which were committed when certain industries which were beginning to be successful were stopped. At any rate Mr. Plunkett deserved the thanks of the Irish people, irrespective of creed, class, or party, for making this honest and manly attempt to benefit his country.

Mr. ALEXANDER MACDONELL said he had always been strongly of opinion that there ought to be other industries in Ireland besides agriculture. Of course at present it was the chief employment, and everything possible should be done for it, but other things should not be neglected. He was in Ireland for many years as a mechanical engineer connected with one of the railways; by the assistance of the directors works were established and by the time he left they were able to build locomotives and carriages as well and cheaply as anyone. He trained some hundreds of pupils and apprentices, and turned out as good engine drivers and firemen as any in England. With regard to education, although it was not possible at present to introduce direct compulsion, a great deal might be done indirectly. For instance, he would not take an apprentice who had not been at school for seven years, and he made all the apprentices attend a night school. If they did not make a certain number of attendances they did not get the usual rise of wages at the end of the year. With a little gentle pressure of that kind a good deal might be done. He did not think an Irishman was so absolutely different from an Englishman as some people supposed, though there were some differences. They had a great idea of equality, and a very clear idea of justice. Still it was a mistake to suppose that an Irishman could be treated in exactly the same way as an Englishman. You might speak to him with a freedom which you could not to an Englishman, without his taking any improper advantage. Unfortunately, many people had been too much inclined to try and force Irishmen out of their own proper grooves. He remembered once, at a friend's house, hearing a gentleman tell a lady that the only way to improve the Irish was to Englishify them; that it was no use dealing with them in any other way. He at once told her that that kind of thing had been often tried, and had always failed. You might make a good Irishman of him, but you would never make him an Englishman.

Lord MONTEAGLE said that Mr. Ashley had spoken of the difficulties he met with when he first went to Ireland as an Englishman, and Mr. Macdonell had somewhat differed from him as to there being such a fundamental difference between the two nations. It occurred to him that one great advantage attending the meetings and discussions of the Recess Committee was that they brought together a number of men of different parties and creeds, and from different parts of the country. It would have been an advantage to get them together for any purpose, but especially so when their object was what had been described; and it seemed to him that that in itself was a very great achievement. That might sound like a platitude in England, but it was not so in Ireland, at any rate not until recently; but the idea was gaining ground, that Irishmen of different parties might meet together in this way for a common object. The Chairman was a distinguished English statesman, who came to represent the best thought of England on these problems, and when Mr. Ashley spoke of the great differences between England and Ireland, it crossed his mind whether meetings and discussions of this kind might not also tend to bring about a better understanding between the two countries which they all desired to see whatever might be their political opinions. Even if Ireland were an independent country altogether, the strongest nationalist would then desire—if he never did before—to have a better understanding with England, and the better understanding there was the more possible it would be for England to carry out these improvements, and to do what could be done to further the prosperity of the sister country. The Chairman, towards the end of his remarks, begged them not to be too impatient, and that advice was perhaps more needed by Irishmen even than by Englishmen. They had not the dogged determination of the English character, and though quick at taking up new ideas, sometimes lacked the energy and perseverance to carry them through; so that if any change were brought about in two or three generations they ought to be satisfied. At the same time, looking at the work Mr. Plunkett had been carrying out in the south and west, which was now spreading still further, there was much encouragement to be derived from the way in which small local societies had been able to manage their own affairs. He remembered the first meeting of some of his tenants, when Mr. Plunkett explained his idea. At the close of the proceedings, the oldest man in the room came up to him and said:—"Couldn't we get some Englishmen to come over and do this for us, because there's no mistake about it, it's a thing that would require that we should have great confidence in a man." He thought this was not a very hopeful beginning for a co-operative enterprise to be conducted by the people themselves; but within a year they had two co-operative dairy societies formed, within three or four miles of each other; and whereas in the first two or three months they were constantly coming to him for advice and assistance, during the last year or two he had seen very little of them beyond the yearly balance-sheet, which showed they were in a very prosperous condition. This was an extraordinary success to achieve in a short time, particularly as these dairies were entirely managed by farmers who had had no previous business experience.

Mr. PLUNKETT, in reply, said the Chairman was naturally a little cautious in acceding to some of the propositions he had laid down, and rather took exception to the doctrine of *laissez faire* being described as moribund, but he only meant it to apply to that extravagant assertion of the doctrine which had led to the extinction of one of those legitimate methods of developing industry which the Committee, with unanswerable evidence from abroad, was now asking the Government to adopt. He also referred to the political differences which surrounded any effort to bring people together in Ireland, and to the feeling some might have that increased contention might militate against obtaining that wider measure of self-government, of which he was a well known advocate. But he thought the line taken by the Committee was extremely fair. They said, by joining together in an attempt to improve the material, industrial, social, and moral condition of the people all parties would be benefited. It would be a test to which all ought gladly to submit their respective policies. If they had any soundness in them, they were bound to prosper with the greater intelligence of the people; and after all the scheme had a large Home Rule element, in fact it was Industrial Home Rule. Dr. Rentoul suggested that they ought to pay far more attention to developing other industries, because agriculture was no longer profitable; but the view taken by many of the Committee was that the creation, or restoration, of extinct industries depended far more on the human element, and on the industrial habits of the people, than on natural conditions; and that the quickest way of developing the requisite qualities was in connection with the industry by which the great majority lived; and this would pave the way for the introduction of other industries. The northern members of the Committee were bitterly disappointed that the Government were not going beyond the establishment of a Board of Agriculture this Session, and they were not sure that even that would be established on the lines which they considered absolutely necessary. With regard to general education, there was no doubt of its importance, but the necessity of avoiding all controversial matters prevented its being considered by the Committee; but, at any rate, it had done something to turn the thoughts of the country to the problem, and when the Report was more widely known, as he believed it soon would be, as an edition was to be published at 1d., he believed there would be such an industrial revival as this generation had not hoped to see.

The CHAIRMAN, in moving a vote of thanks to Mr. Plunkett, said there was something almost tragic in the way in which some of the speakers referred to the novelty of the idea of a number of Irishmen of different creeds and parties meeting together to consult on questions affecting the welfare of their common country. Those who were familiar with such meetings in England and Scotland, could not help feeling how melancholy it was that it should be left until last year for a new departure of that kind to be made in Ireland. Nothing could show more forcibly how politics had interfered with the legitimate economic growth of Ireland, and it was very largely in those political and historical matters that were to be found the sources of the difference between English and Irish to which Mr. Ashley had alluded. Though this was a matter for regret, it also gave ground for hope that, when these unfortunate differences were removed, new habits and ideas would grow up, and the differences of the past would be forgotten.

The vote of thanks was carried unanimously, and the meeting adjourned.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

FEBRUARY 10.—"The Chemistry of Tea." By DAVID CROLE. SIR STEUART COLVIN BAYLEY, K.C.S.I., will preside.

FEBRUARY 17.—"Light Railways." By EVERARD R. CALTHROP. The ATTORNEY-GENERAL, G.C.M.G., M.P., will preside.

FEBRUARY 24.—"Reproduction of Colour by Photographic Methods." By SIR HENRY TRUEMAN WOOD, M.A.

MARCH 3.—"English Orchards."—By GEORGE GORDON. W. T. THISELTON DYER, C.M.G., F.R.S., Director of Kew Gardens, will preside.

MARCH 10.—"The Prevention of Fires due to the Leakage of Electricity." By FREDERICK BATHURST. W. H. PREECE, C.B., F.R.S., will preside.

MARCH 17.—"English Music in 1837: a Sixty Years' Retrospect." By J. SPENCER CURWEN. SIR WILLIAM CLEAVER FRANCIS ROBINSON G.C.M.G., will preside.

MARCH 24.—

MARCH 31.—"Cycling—Historical and Practical." By GEORGE LACY HILLIER.

Papers for evenings, the dates of which cannot yet be announced:—

"Dairy Produce and Milk Supply." By M. J. DUNSTAN, M.A., F.R.S.E.

"The Transmission of Power by Alternating Electric Currents." By W. B. ESSON, M.Inst.C.E.

"London Water Supply." By PERCY F. FRANKLAND, Ph.D., F.R.S.

"The Evolution of the Silver Question." By MORETON FREWEN, B.A.

"Children's Sight." By R. BRUDENELL CARTER, F.R.C.S.

"Fireproof Construction." By THOMAS POTTER.

"Motor Traffic: Technical Considerations." By Sir DAVID SALOMONS.

INDIAN SECTION.

FEBRUARY 11, at 4.30 p.m. "The Progress of Science Teaching in India." By PROFESSOR JAGADIS CHUNDRA BOSE (of Calcutta), D.Sc. Sir JOHN LUBBOCK, Bart., F.R.S., will preside.

⁂ This meeting will be held at the Imperial Institute.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock :—

FEBRUARY 16.—"The Progress of Canada during the past Sixty Years of Her Majesty's Reign." By JOSEPH G. COLMER, C.M.G. The MARQUIS OF LORNE, K.T., will preside.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock :—

FEBRUARY 9.—"Lithography as a Mode of Artistic Expression." By GEORGE MCCULLOCH. JOSEPH PENNELL will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

WILLIAM BURTON, F.C.S., "Material and Design in Pottery." Four Lectures.

LECTURE IV.—FEBRUARY 8.

Porcelains.—The results of adding fusible materials to a natural clay: effects on the plasticity; effects on the fired body; effects on the nature of the glaze—Porcelain the connecting link between pottery and glass—Oriental porcelain and its distinctive qualities—The various attempts made to reproduce it in Europe—Artificial or soft-paste porcelain—Hard-paste porcelain—The artificiality of the European product—An outlying member of the pottery family—The influence of porcelain on the native pottery of Europe.

HOWARD LECTURES.

Thursday Evenings, at Eight o'clock :—

PROF. JAMES A. EWING, M.A., F.R.S., "The Mechanical Production of Cold." Six Lectures.

FEBRUARY 11.—LECTURE III.—Modern vapour compression machines—Agents used—Theory of the process—Influence of temperature—The critical point—Comparison of ideal performance with various agents.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 8... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. William Burton, "Material and Design in Pottery." (Lecture IV.)

Imperial Institute, South Kensington, S.W., 8½ p.m. Dr. J. L. W. Thudichum, "European Wines and their Manufacture."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. J. W. Willis Bund, "Allotments and Small Holdings."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Paper by Captain Abney.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Cyril J. Davenport, "Decorative Bookbinding from Mediæval Times."

TUESDAY, FEB. 9... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. George McCulloch, "Lithography as a Mode of Artistic Expression."

Royal Institution, Albemarle-street, W., 3 p.m., Prof. A. D. Waller, "Animal Electricity." (Lecture IV.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. H. F. Donaldson's Paper, "Cold Storage at the London and India Docks."

Photographic, 12, Hanover-square, W., 8 p.m. Annual Meeting.

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. The Hon. T. A. Brassey, "Studies in Australia in 1896."

Asiatic, 22, Albemarle-street, W., 4 p.m.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m

WEDNESDAY, FEB. 10... SOCIETY OF ARTS, John-street, Adelphi, S.W., 8 p.m. Mr. David Crole, "The Chemistry of Tea."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. F. J. Waldo, "Sanitary Supervision of Shelters for the Homeless."

Japan Society, 20, Hanover-square, W., 8½ p.m. Mr. Samuel Tuke, "Japanese Tori-i."

United Service Institute, Whitehall, S.W., 3½ p.m. Colonel Lord Raglan, "The Militia."

THURSDAY, FEB. 11... SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section, at the Imperial Institute.) Professor Jagadis Chundra Bose (of Calcutta), "The Progress of Science Teaching in India."

8 p.m. (Howard Lectures.) Professor James A. Ewing, "The Mechanical Production of Cold." (Lecture III.)

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m Mr. Arnold Dolmetsch, "Italian, French, and German Music of the 16th, 17th, and 18th Centuries."

Society for the Encouragement of Fine Arts, 9 Conduit-street, W., 8 p.m. Mr. James Orrock, "William Müller," with Illustrations by the Painter.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. J. W. Gregory, "The Problems of Arctic Geology." (Lecture I.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Continuation of Discussion on Mr. F. T. Hollins's Paper, "Electric Interlocking the Block and Mechanical Signals on Railways."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Birt Acres, "The Making and Exhibiting of Living Photographs."

FRIDAY, FEB. 12... Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. John Milne, "Recent Advances in Seismology."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Students' Meeting. Mr. Harold W. Barker, "Cooling Reservoirs for Condensing Engines."

Astronomical, Burlington house, 8 p.m.

Philological, University College, W.C., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. Annual Meeting.

SATURDAY, FEB. 13... Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m., Mr. W. F. Lord, "The Growth of the Mediterranean Route to the East." (Lecture I.)

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

REPRODUCTION OF COLOUR BY PHOTOGRAPHIC METHODS.

As a number of members have expressed a wish to hear the paper on the "Reproduction of Colour by Photographic Methods," which will be read by the Secretary on the 24th inst., it has been decided to ask the members to forego the privilege of introducing friends by ticket on that evening. It is thought that this arrangement will be for the general convenience of members, and will allow a greater number of them to be present. If they wish to do so they will still be entitled to introduce personally a single friend.

CANTOR LECTURES.

Mr. William Burton, F.C.S., delivered the fourth and last lecture of his course on "Material and Design in Pottery," on Monday evening, 8th inst.

The Chairman (Mr. J. S. Neville) proposed a vote of thanks to the lecturer for his valuable course of lectures, which was carried unanimously.

The lectures will be printed in the *Journal* during the summer recess.

HOWARD LECTURES.

The second lecture of the course on "The Mechanical Production of Cold" was delivered on Thursday evening, 4th inst., by Professor James A. Ewing, M.A., F.R.S.

The lectures will be printed in the *Journal* during the summer recess.

APPLIED ART SECTION.

Tuesday evening, February 9, 1897; Joseph Pennell in the chair.

The paper read was on "Lithography as a mode of Artistic Expression," by George McCulloch.

The paper and report of the discussion will be published in a future number of the *Journal.*

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal,* cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, February 2nd, 1897: The Earl of Jersey, G.C.M.G., in the chair.

The paper read was—

THE PROGRESS OF THE BRITISH COLONIAL EMPIRE DURING THE SIXTY YEARS OF HER MAJESTY'S REIGN.

By the Right Hon. Sir Charles W. Dilke, Bart., M.P.

It is, I feel, an honour to be called on, under the chairmanship of Lord Jersey, successful governor of a great colony, and equally successful representative of the British Government at a Colonial Conference, to address (in a hall well-known to me in my youth) a branch of a Society of which I am one of the senior living members. Barry's pictures remind me of days when I, as a child, was often in this room at the time of the organisation of the Educational Exhibition. I was even present, in an adjoining little room, as a secret but unlearned listener, at that memorable meeting of July, 1849, when "The Exposition," or "National Exhibition" became the first great International Exhibition, at the suggestion of Mr. Thomas Winkworth.

A general survey of the British Colonies was attempted by Montgomery Martin in 1834, and

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its date is so immediately antecedent to that of the commencement of Her Majesty's reign, that Martin's book may almost be said to give us a view of the colonies as they stood at the moment at which their special interest for us to-night begins. Martin uses the word "colonies" in a wide sense, to include all dependencies of the United Kingdom across the seas, however governed, which when he wrote, either as colonies of inhabitancy or as colonies of production, or as protectorates, or by personal union were connected with the British crown. Almost the whole of his first volume is given to India, which in the sense in which we now use the word "colony" is not commonly so described. You of this committee will doubtless not expect that I should deal in the present survey with the countries which are under the control of the India-office. These no longer include, as they once did include, the Straits Settlements; but on the other hand India does include Aden, which is one of our coaling stations, and the protectorates in Arabia, and on the Somali coast and in certain islands, which are dependent on the Government of Aden, itself a dependency of the Indian province of Bombay.

Martin pointed out, in his dedication to King William IV., that the transmarine dominions of the United Kingdom offered markets for our trade and land where industrious Britons might settle, either as true colonists or as planters intending to return; but he grieved that the intrinsic worth of our colonial possessions was not understood, and not appreciated; that the people of our kingdom had neglected the maritime power of their country; and that danger had arisen of both the mother country and the colonies being irrevocably lost.

After a long period of neglect, the colonial parts of that Empire of the English tongue and of British institutions, which forms the true *Greater Britain*, have assumed a larger bulk in the eyes of the people of our home possessions, and our maritime supremacy has again been, we may hope, asserted. The relative importance of our colonies has greatly changed since the beginning of the reign, although their total importance has, of course, enormously increased. The West Indies, with the neighbouring colonies, played a far larger part, proportionately speaking, in 1837, than they play now. But it is a mistake to assume that those colonies are ruined. Individuals have suffered, and some of the islands have suffered, taken by themselves, but, on the whole, there has been an increase even of the white population, an enormous increase of the coloured population, a fabulous increase of the revenue, and an increase in trade. When we come to detail, we find that in British Guiana, where the white population has been stationary through the Queen's reign, there is a great increase of the coloured population—caused by the bringing in of Hindoos—that the revenue is ten times what it was at the time of the Accession, and that the imports have vastly increased. Even in Jamaica, although the white population has decreased, the revenue has been tripled. In Trinidad, the total population is five times as great as it was at the Queen's accession, the revenue twelve times as great, and the exports ten times as great. In Tobago, the population has increased, but the island is poorer. It is, however, a small colony. In Grenada, the population has increased, and the revenue is five times as great. In St. Vincent, both the white population and total population have greatly increased, while the revenue has doubled. In Barbadoes, the population has more than doubled, the revenue is ten times as great, the imports three times as great, while the exports have increased, though not in the same proportion. St. Lucia has three times the population that it had, and has five or six times the revenue, treble the imports, and double the exports. Dominica, to which the British Parliament has just voted money from our taxes, on account of its exceptionally bad position among the West Indies, has increased its population, while the white population of the Leeward Islands, the group to which it belongs, taken as a whole, has also increased during the Queen's reign. The revenue of Dominica has trebled, but its trade has declined. Of Montserrat the population and the trade have increased, while the revenue has trebled itself. Antigua has a stationary population, and its trade has slightly decreased; but its revenue is again treble. St. Kitts and Nevis have increased their population, while Anguilla has a stationary population, but the trade of the three taken together has largely increased, and the revenue has been quintupled. Bahamas has trebled its white population, more than trebled its total population, trebled its revenue, nearly trebled its trade, and doubled its exports in the same time. Of Bermuda the white population has increased, the total population has doubled, the revenue has trebled, the exports more than trebled, and the imports more than trebled. Honduras has multiplied its population by eight, and more than doubled its revenue, greatly increased its exports and its total trade.

On the whole, what used to be called the West Indies (as for instance in the Government Returns of 1831 and 1842—not published till 1845), which are what we now call the West Indies, with the addition of Bahamas, Bermudas, and the mainland possessions of Honduras and Guiana, have a far larger population and a much greater revenue than they had at the Queen's accession; but there is, perhaps, a falling off in the amount of their produce sent to the mother country, and in the export of her produce to them. This falling off is itself not certain, as the "official value" in 1837 was double the "declared value," and if we take the latter there is an increase. In the case of some of the West Indian colonies, trade with the United States has taken the place of home trade. On the whole the trade of these colonies has increased, although there has been in some particular cases a decline.

These figures, although, of course, far from conclusive, are curious in face of the general belief that the West Indies present a picture of uniform decline, wholly different from the progress general throughout Her Majesty's dominions.

In Ceylon, we possess one of the most beautiful, and one of the most interesting portions of the earth's surface. Whether for scenery, for costume, for the remains of early civilisations, or for peculiarities of religious worship, Ceylon is equally attractive; and after a period of decline, caused by the destruction of the coffee industry by disease, Ceylon has more than recovered her prosperity, through the brilliant enterprise with which the settlers have turned to the planting of a fine tea. In mentioning Ceylon I should perhaps call attention to the fact that this important strategic point is much more lightly held by us in a military sense than it was at the accession of the Qneen. There were in those days, besides artillery and body guard, four whole regiments of British infantry, and 2,000 local Malay troops in the island. Although local circumstances, as well as our present recognition of the fact that the possesion of islands in time of war must depend mainly upon naval supremacy, may account for a decrease in the force kept on foot within the sland, yet I may take this opportunity of emarking that even as against light attack, nd even if considered only from the point of view of manning fortifications required by the fleets for the protection of their bases of operations, our garrisons of many of the islands and coaling stations would have to be increased on the outbreak of war, an operation for which there might not be time, and which in any case would add greatly to the burden of the navy at a moment when we could ill afford to interfere with its scientific mobilisation. No doubt in the case of Ceylon, the great falling off in the garrison is partly accounted for by the fact that after the war with the population of Kandy and of the interior of the island, a considerable force had to be kept up for a certain time on the chance of a renewal of operations. But, in any case, there has been a large decline in military strength on the island as compared with early normal periods.

The revenue of Ceylon is about four times as great as it was at the accession of Her Majesty. The nature of the trade of the country has greatly changed, for at the time of the Qneen's accession, Ceylon had hardly freed itself from that monopoly system which had been introduced by the Dutch while it was a Dutch colony, and which continued in Java till a much more recent period. It is interesting to remember, as some used to express the wish that we should introduce into Ceylon the Dutch culture system, which formerly prevailed in Java in its full strength, an imitation of which has indeed been introduced by us into Fiji, that the abuses of that system were thoroughly felt in Ceylon before the Queen's accession, and that the system was put an end to there with general applause. The increase in British shipping entering the ports of Ceylon in a year will give a shock of astonishment to my hearers. Although the colony was looked upon as flourishing at the time of the Queen's accession, the tonnage of British shipping (without India) was only about 10,000 tons entering Ceylon ports, and with India about 40,000 tons; whereas in the year 1894 the tonnage of British ships entered and cleared, exclusive of coasting trade, was 5,452,547 tons. The trade of Ceylon at the Queen's accession was the export of cinnamon, and the import, to pay for it, of Indian grain, and Indian cotton goods. The trade of Ceylon of those days in and out was about £500,000 sterling a year. The trade of Ceylon in 1894 was, exports 80,000,000 of rupees, and imports 78,000,000 of rupees. Cinnamon has almost disappeared. The import trade into Ceylon from the United Kingdom, which was almost *nil* at the Queen's accession, is now £4,000,000 sterling a year, of which £1,000,000 sterling worth is British produce. Ceylon sends us fabulous amounts of tea, very large amounts of cocoa-nut products, and still a good deal of coffee, with an increasing amount of cacao. Ceylon by her enterprise has almost displaced China tea in the British market, although she has not yet won the market of the world. She exported 100,000,000 lbs. weight of tea in 1895, although eleven years previously her export had only been 2,000,000 lbs. weight. There is probably no colony to the work in which of men of our own race we can look with greater pride than that with which we should survey the enterprise of the planters of Ceylon. A complete change of public taste, such as that which has discontinued the use of cinnamon as a spice, would have ruined many a foreign colony for ever: just as the disuse of currants would ruin a whole kingdom—that of Greece. But in the case of Ceylon, the disuse of cinnamon, followed by the loss of fortunes in coffee planting, after the bushes were attacked by the disease, only led to fresh experiments in all directions, and to the final triumph of tea, while other new products, such as bark, have more than filled the place (when tea is left out of the account) which cinnamon once held.

The Straits Settlements are also countries of which we may be proud. The exchange of rights which we made with the Dutch, which conceded to them whatever influence we may rightfully have claimed in Sumatra, has been a fatal inheritance to them, whose colonial empire has been ruined by the wasting at Acheen of the revenues of Java. In the Malay Peninsula we have, beginning with the port of the island of Singapore and with Penang, established ourselves in large colonies, and in protectorates over Malay states, with the result of everywhere steady, and in some places rapid, development of the resources of the Peninsula. The revenue of the settlements of Singapore, Penang, Malacca, and Province Wellesley, which were the whole of our establishments in the Malay Peninsula at the time of the Queen's accession, was £250,000 sterling. The trade, including opium, which was an Indian monopoly, was extremely small; although a little tin had begun to be worked upon the surface. Already in Montgomery Martin's time Singapore had been described as a "rapidly rising emporium of trade;" but its rise was only comparative. In 1820 it had been inhabited by 150 Malays, described as half fishermen and half pirates. At the time of the Queen's accession there was a population of 25,000, of whom the Chinese formed one-third, and the Chinese had been attracted by the prospect of trade, and were described as consisting to some extent of wealthy merchants. The imports and the exports had become considerable, and formed a trade in and out of between £3,000,000 and £4,000,000 sterling a year, consisting of imports from China and exports to England; figures which continued to justify what Montgomery Martin had said in 1834. But, although since that date Hong Kong has come into existence and has to some extent taken the place of Singapore as an emporium of China trade, yet the transit trade of Singapore has enormously increased even in recent years, and reached in 1894 300,000,000 dollars. The Straits take £2,250,000 of British produce, which they pay for almost exactly in a similar quantity of tin. The tonnage of ships cleared annually in the Straits (exclusive of coasting trade) amounts to close upon 10,000,000 tons.

Singularly like Singapore in its position as a place of transit is Hong-Kong. Similar, too, in its history on one point, for, being a well-chosen place for trade, it was first a well-chosen place for piracy, and, like the island of Singapore, the island of Hong-Kong was once a nest of fisher-robbers. A famous Portuguese settlement had dwindled in the neighbourhood when we took the rock in 1841. There can be, in the case of Hong-Kong, no comparison with its position at the accession of the Queen, for, practically, Hong-Kong dates from 1843, and is only six months older than myself. Hong-Kong was once part of China, but in those days hardly any Chinamen dwelt upon it, and the 250,000 Chinese who dwell there now have been attracted by our rule. Some of them are far from being desirable inhabitants, for, unfortunately, the punishments of the Chinese law being somewhat severe, Hong-Kong has become the Alsatia of China, and we, in consequence, have to face both riot, arson, and plague as denizens in our midst. Piracy also prevails on the little passenger craft that are the "penny steamboats" of the colony; so that life there is not without its drawbacks. Hong-Kong is a beautiful city in a beautiful situation, but it would have to be a hell indeed not to offer a temptation as a residence to the pirates driven by the Chinese police from the Canton river. When Sir Charles Kennedy and I were serving together in the Foreign Office, I had a prolonged interview with the Marquis Tseng, the Chinese Ambassador, about the fate of a large band of Chinamen who had taken refuge in the colony. They had undoubtedly committed piracy and murder, and we did not want them at all, but we have scruples and soft hearts in England. One of these interesting gentlemen was a kind of Welsh or Breton cousin—let us say a distant relative—of some other interesting gentleman who had been murdered by one of the first gentleman's friends, a member of his party. Just as in England a man who, committing an unlawful act, say shooting at a pheasant which is not his, kills somebody accidentally, is guilty of murder by a construction of our law, although there was no premeditation, so in China a man who is one of a party, engaged on a murder, of which some member kills a relation of his own, is constructively guilty of the crime of parricide. Now the punishment of parricide in China is chopping into 10,000 pieces, and unless the executioner is bribed, it is, I believe, usual to commence the process on the living person, whereas if the executioner chooses the chopping into 10,000 pieces may be done when it does not so much matter, that is after you are dead. We had reason to believe that if the pirates, whose heads we were very willing to have cut off, were handed over in this case, some or the whole of them would be chopped into 10,000 pieces, and we tried, for a long time, to persuade the Chinese authorities that they had better quietly agree to merely chop off their heads in the presence of a British representative, instead of insisting, as a point of honour, on chopping them into 10,000 bits. We argued and argued, and the Chinese argued too, and nothing came of it. I courteously explained to the Marquis Tseng that no doubt it was a prejudice on our part; that Madame de Sévigné herself had defended torture, that it had been practised in France under Louis XVI. in the capital city of the most civilised of Courts; but that opinion had changed rapidly in Western Europe, and that the Chinese were only a little more conservative than ourselves; but that, all the same, I really could not, speaking for the Secretary of State, allow these worthy pirates to be chopped up in the way proposed. Some of them, I believe, died of old age in gaol; the others were gradually allowed to escape; and any who are still surviving, owing to the obstinacy of two great Governments, no doubt pursue to this day their ordinary avocation.

Hong-Kong, on the whole, may be regarded as having had, commercially speaking, the most flourishing history of any settlement in the world. Hong-Kong is an island which produces nothing. It is a free port which forms a centre of trade, and has not, like the port of Singapore, a country in its neighbourhood, under the same flag, which has a mineral and agricultural production. Hong-Kong is a port, and nothing else, with an annual trade of about £50,000,000 sterling; and it is also the principal coaling station of the British fleet in the north-west Pacific.

Mauritius presents us with a somewhat less attractive picture, but it is interesting as the home of an intelligent population of French blacks and half-castes, who flock in such numbers to the English bar that some people imagine that the whole of the natives of the island are barristers. The Mauritius coloured people of mixed race speak French well, and are thoroughly French in their ideas,—read French literature and look upon themselves as French. It must have been a terrible blow to them the other day, when one gentleman from Mauritius, who had obtained a concession from a French Governor of Madagascar, had his concession cancelled, after a debate in the French Chamber, because he was looked upon as a Briton. He vainly explained, in letters which were read, that he was practically a Frenchman; but in spite of his French name nothing would profit him in face of his British nationality. Mauritius was one of our latest conquests in the great war; captured by us in 1810, though we could ill spare the 12,000 troops that had to be sent there for the purpose across the seas, because the privateering of the French, carried on from the island, had made our life in the Eastern seas a burden to us. The French, however, were allowed to keep some other islands in the neighbourhood, which had also been captured by us during the war; and they have lately, by our unfortunate permission, occupied British Sound (or Diego Suarez as it is now called)—the magnificent harbour of the north of Madagascar, which has become the rallying point for the whole of the conscripts of the French mobilised forces of the East in the event of war. Let us hope that if ever war should come about, British supremacy at sea may be so complete that the troops directed to meet in Madagascar may be unable to reach that point. Mauritius, however, continues to be a most important coaling station for our naval predominance in the Indian seas, in which, it should also be remembered, that France had been able to dispute our sway in the time of Louis XV. and of Louis XVI., when they think they beat us under the Comte de Grasse, and the Bailli Suffren de St. Tropez. The population of Mauritius when we took it consisted of 7,000 whites, 6,000 free coloured people, and 70,000 negro slaves. The population has now enormously increased, but chiefly by the introduction of Hindoos; and over two-thirds of the population are now Indian, while there are probably more Chinese than there are pure whites. In consequence there are hardly any people of any of the ordinary British religions; hardly any members of the Church of England, of the Presbyterian Churches, or of the Nonconfomist bodies. Almost all the whites, coloured people, and negroes, are Roman Catholics, while almost all the others are Mohammedan Indians or Hindoos. The language, as I have said, is French, intermixed with the tongues of India; and the laws, by our tolerance, are those which prevailed under French rule. It may be noted in passing that the Queen's reign has seen no change in the main body of the law of our colonies; that the law of the Cape and of Guiana continues to be Roman-Dutch, and the law of many of our other colonies the Code Napoléon, so respectful are we towards the manners and customs of those we conquer. The British Privy Council has indeed to administer laws more varied than those which have ever come under the consideration of any tribunal in the history of the world.

It would be a mistake to suppose, in spite of the depression which has been complained of in Mauritius, that this colony, any more than the West Indies, is in a starving condition. Contrary to the experience of the West Indies, the revenue of Mauritius has, it is true, fallen off in modern times, for a very large revenue indeed was levied in Mauritius at the accession of the Queen. The trade of Mauritius has increased since the accession, but not by very much. The imports are increasing, and the exports, although they vary greatly, have, on the whole, lately shown some increase. The exports of British produce to Mauritius have indeed displayed some falling off, and, on the whole, Mauritius, depending mainly on the sugar industry, and not having as yet succeeded in imitating some of the West Indies by finding other articles of trade, must be looked upon as stationary, and in a position not satisfactory as regards the future. Madagascar in 1837 was counted among the dependencies of Mauritius, and indirectly, therefore, among the possessions of the British crown. It became during the Queen's reign the home of an interesting civilization of a British type, and the happiest field of our missionary societies. All this has now been wrecked and is dead for ever; but it must be admitted that Madagascar had been in dispute between England and France during 200 years of history, and that if we had some right to claim that Madagascar had followed Mauritius under our flag, the French go back to still earlier times, in which both Richelieu and Colbert had intended to give, rather than had given, Madagascar to the French crown.

It will not be necessary for me to discuss the position of those colonies which are mere coaling stations, and, on the other hand, it would perhaps carry me too far were I to state at length the prospects held out as regards the future by what may be called the colonies of the future — the Protectorates under the Foreign Office, such as those of the Oil Rivers (Niger Coast), and of Zanzibar, the spheres of the Chartered Companies, and the spheres of influence, which are the creation of the last few years. Montgomery Martin included under British colonies, not only India, but the Ionian Islands, which were an independent republic under our protection; the Isle of Man, which is a separate kingdom; and the Norman Isles, of which I believe we are ourselves a colony. The Channel Islands are what remains to the British Crown of the Duchy of Normandy—and, as an Irishman might say, are an older possession of the Crown of England than is England itself. They admit the sovereignty of the Queen, and they concede to the Home Secretary the right of speaking to them in the Queen's name; but colonies of England they cannot in any sense of the word be held to be; and even more than India, and as much as the Isle of Man, they are outside the sphere of our inquiries to-night. I come, then, therefore, to the three great groups of colonies; those of South Africa (in the main the Cape and Natal), the Dominion of Canada with the colony of Newfoundland, and the Australasian group.

To deal first with South Africa. Natal, like Hong-Kong, is a colony younger than the Queen. It was in the year of the Queen's accession that the Boers from Cape Colony marched against the Zulus, placed their own king, Panda, on the Zulu throne, and conquered the territory which now forms the colony of Natal. Three years later British troops marched against the Boers, who surrendered, and in the year of my own birth—the year of the birth of the colony of Hong-Kong—1843, Natal became a British colony. Although founded as a colony in the first place by Dutch Boers, Natal has been so much settled by English and Scotch colonists that it is far less Dutch and far more British than is the Cape. It is also, I may add, less Irish than are the colonies of Australia. As a general rule in the British colonies the Scotch element and the Irish element are both of them somewhat stronger, and the English and the Welsh element somewhat weaker than they are in the United Kingdom; but in Natal we have an extremely British colony, owing to the smallness of the Irish-born proportion. Natal, however, is still more Kaffir than it is English. Contrary to the advice given by a man of great weight in matters of colonial history, Mr. Greswell, who wrote in "Our South African Empire," against giving parliamentary and responsible government to small communities of whites, living in the same territory with enormous numbers of blacks, responsible government has recently been granted to Natal; and, as I myself share Mr. Greswell's view, I should be thought impartial if I say, against my own preconceived opinion, that no ill-consequences seem to have happened from the grant. Natal possesses a moderate and a steadily-increasing prosperity.

The Cape is mainly a Dutch community. The natives, although they outnumber the whites, are far less strong than they are in Natal. The Dutch outnumber the British, and Dutch and British happily co-operate in the parliamentary institutions of the country, and in its trade and agriculture. A somewhat old-fashioned and Conservative community is the result, in which inter-marriage between the two main white races is creating a good blend, which may end in absorbing both into a common product, just as the very numerous French Huguenots (whose names are unrecognisable, through the Dutch pronunciation, until they are written down) have been absorbed by the Dutch.

A result of the predominance of Dutch blood among the whites of the Cape has been that legislation there with regard to the position of he blacks has been what some of us are inclined to think retrograde. The Glen Grey Act has introduced labour provisions which to ome of us savour of bondage, and the recent hanges in the franchise laws have been, not, s throughout Australasia, in the direction of enfranchisement, but in the opposite direction of disfranchisement or contraction of the suffrage. It would be outside our sphere if we were to dwell upon such considerations, which would indeed be the subject of dispute as to the alleged facts. But I may perhaps be permitted to say on my own account that the one point, and perhaps the only point amid many examples of progress, in which the British dominions have receded from the position they occupied in the world at the accession of the Queen concerns the treatment of the native races. It is doubtful whether the anti-slavery policy, of which we were proud, is so universally accepted as it was by both statesmen and public 60 years ago.

The total tonnage of shipping, inwards and outwards, of Cape Colony at the time of the Queen's accession was about 150,000 tons. It is now 3,500,000 tons. The annual commerce of the country was then £600,000. It is now £27,000,000. Although the wool export of South America and Australasia has received fabulously great development in the Queen's reign, the wool trade of the Cape has not, as some might imagine, fallen off, but has continually increased. The political importance of Cape Colony is, however, much greater even than its increasing commercial moment In the event of serious war the Cape at once becomes, with Gibraltar, one of our two most important maritime stations in the world; and that trade to the East, which is our life, which could not be conducted through the Mediterranean on profitable terms in face of the war-risks insurance, would pass round the Cape of Good Hope on a line which it is to be expected our cruisers would be able to patrol. Telegraphic communication in British hands, through British stations to the Cape, and from the Cape to Australia, and to India by Mauritius, would seem to be essential to this trade, and its protection in time of war. At the present moment our telegraphs to the East all touch at points within Russian, Persian, Turkish, or Portuguese control, and there can be no concern of British trade and defence more pressing than British lines from the home country to Gibraltar, from Gibraltar to Sierra Leone, of which the garrison is to be strengthened, and from Sierra Leone by the British Settlements of the West Coast to the Cape.

Turning to North America, the colony of Newfoundland arrests our attention as being about the oldest of British colonies, as being the seat of a historical struggle between England and France which may still lead to international complications, and as being outside of that Dominion into which British and Canadian Governments have vainly tried to lead it. Newfoundland has not made that material progress during the Queen's reign which is noticeable in most of the other colonies of which we have spoken or shall have to speak. Fish do not as a rule greatly increase in numbers, and fish on the Newfoundland coast, or on the neighbouring Banks, cannot draw nearer to the markets. The prosperity of Newfoundland depends chiefly on fish, and cannot, therefore, show the same increase which is to be looked for in the colonies which have manufactures or transit trade, or mines, although, in the long run, Newfoundland will not be without the latter. Newfoundland is the only British colony in which we are unable to protect the rights of British subjects to the practical enjoyment of the whole of their own territory. At the time of the Queen's accession, the French claim of exclusive right of fishing on what they call the French shore, was the occasion of heated discussion in the colony and in Parliament; and, although 60 years have passed, the question is still with us, and the dangers which flow naturally from its unsettled position, are increased rather than diminished. In spite of all difficulties, however, the revenues of Newfoundland have greatly grown; so has the tonnage of shipping cleared. The imports and exports of the colony have not greatly increased, although they are larger than they were at the Queen's accession.

We have hitherto been concerned more with commercial than with political change, but when we turn to the Dominion of Canada, the revolution which has marked the reign of Her Majesty, attracts us more in its political than in its commercial side. In 1837, French Canada was in rebellion. The 60,000 French colonists who had become British subjects in 1763 had accepted their new nationality. During the wars in which the United States attempted to drive us out of Canada, the Canadians fought upon our side. Papineau himself, who was the rebel leader of 1837, had fought for us in arms against American invasion; but we had attempted to absorb the French, we had tried to force upon them our laws and tongue, and to hamper them in the enjoyment of their religion. They had grown rapidly in numbers. They were supreme in what was then the most settled part of the country; and, although we put down their rising, we happily conceded their demands. The result has been that the liberties granted to French Canada have not only pacified the country, but have converted the province of Quebec into one of the most loyal portions of the Empire. There are now on the American continent, many of them in the United States, over 2,000,000 of pure French Canadians, and, although they cling to their institutions, which are those of France of the last century, and intellectually and sentimentally look to France as the country of their dreams, their intense social Conservatism makes them the strongest supporters of a rather Conservative type of British rule, and has led to the historical declaration that the last shot fired on the American continent in defence of Britain will be fired by a French Canadian.

It is a somewhat connected observation, although it leads us into a still wider field, that Canada presents, with Switzerland, the most successful example of federal institutions. The Canadian constitution has had the advantage of following in sequence that of the United States, and our statesmen, and those of the Canadian provinces have been able, therefore, to avoid some of the difficulties and dangers which the United States have not escaped. In the struggle in the modern world between socialistic and individualistic tendencies, Canada, however, stands with the United States on the individualistic side, and is developing a social policy wholly different from that towards which Australasia tends—at all events in the colonies of New Zealand, South Australia, and Queensland, Victoria, politically Conservative, develops a State Socialism of a slightly different type from the more advanced Democratic movement of New Zealand; and Western Australia is still in the stage of gold fever, while Tasmania is, compared with the rest of Australasia, a little stagnant. New South Wales has seen for some years a conflict between different tendencies, but on the whole, Australasia is setting in a Socialistic direction, whereas Canada is more individualistic than the mother country, and socially (as well as geographically) alongside of the United States.

Canada, during the Queen's reign, alone among the British colonies, has become a great maritime state, and has a merchant shipping which stands very high indeed in that list of the shipping of the world in which the United Kingdom has an immense supremacy. While Lower Canada, inhabited mainly by French Canadians, has, on the whole, poor soil, and cannot show rapid advance, Upper Canada or Ontario, colonised originally by the United Empire Loyalists from the old colonies, and more recently mainly by the Scotch, has shown steady growth. From Ontario partly, and partly from the British Isles, there has poured into the Far North-West a remarkable immigration of good settlers, and the wheat-growing lands of the three new provinces, the gold-fields of British Columbia, the coal mines of the Canadian Rocky Mountains, and the fisheries of the Pacific Coast are all growing wonders of the later years of the Queen's reign.

I have left for the last that Australasia, which is the chief—commercially speaking and in the world of social progress and democracy—of the colonial marvels of our time; although politically considered the development of the federal principle in Canada is equally deserving of attention. It is to be hoped that the Queen's reign will not end without Australian Federation having crowned Australian development. It is, however, idle to hope that the whole of Australasia will come in to an Australian confederacy. The Fiji Islands, which are within the scope of the present Federal Council of Australasia, are not likely to be invited, upon equal terms, to join any such association of great white Powers, and New Zealand undoubtedly prefers to remain outside federation until, if ever, it shall be invited to come into some scheme of Imperial Federation or direct alliance with the mother country.

The beauties of Ceylon are of a tropical nature, like the beauties of Central America and of the West Indies. New Zealand, also one of the most beautiful portions of the globe, has loveliness of a different type. In many ways New Zealand reminds us of Japan. The settlers are fond of calling New Zealand "The Britain of the South;" but the geographical and climatic resemblance to Japan is more close. The British Islands have a climate not essentially different between south and north. There is no great distinction between the climate of the Lands End and of the Orkney Islands. New Zealand, like Japan, is almost tropical at one end, and, being of great length from north to south, has often very heavy snowfalls at the other. New Zealand possesses in the greater portion of its territory a delightful climate, in which the British race can thrive and work. It is free from the great heat of the Australian continent. It is plentifully supplied with rain and rivers, and, although too distant from other lands to have a transit trade, possesses magnificent resources of its own.

At the time of the Queen's accession parts of New Zealand were, in the Greek sense, a British colony, for a small British population, partly consisting of whalers, and largely consisting of "loafers" (or "beach combers," as they are called in the Pacific), had settled upon its coasts. We went there, as a Government, rather against our will, in order to obtain authority over these lawless people, to prevent piracy and oppression of the natives. The islands were claimed as British from 1840, and in 1842 were separated from the mother colony of New South Wales, which, at one time or another, has been the nominal holder of all parts of Australia and New Zealand. The colonisation of New Zealand on the Wakefield system, somewhat similar to that of South Australia, was conducted under Royal Charter by the New Zealand Company, and the Church settlement of Canterbury, with Christchurch as its capital, and the Scotch Presbyterian settlement of the south, containing Dunedin and Invercargill, and extending to Stewart Island, were a result. I need not take up time by explaining how a provincial system waxed and waned, but in recent times New Zealand has become a single Government of a non-federal type, and has now come into the hands of a democratic administration (under a statesman once a miner's agent), which for some years past has been attempting remarkable experiments in legislation.

It is perhaps a curious fact that New Zealand should be at the present time the show colony of the Radical democracy, because there is no other colony in which men of good English family are more plentiful, and most of these, settled as large farmers, are of highly Conservative views. On the whole, however, the classes in New Zealand get on well together, and use civil language of one another in spite of their political differences; and there is not that somewhat fierce asperity existing on the part of the moneyed men with regard to their democratic rulers that sometimes has marred the politics of Australia. Perhaps the glorious scenery of the New Zealand bush and mountains, the presence in every landscape of great snowy Alps, the free blowing of the soft New Zealand winds, tend to make people's livers in better order there than in the hot winds and monotonous plains of the greater portion of Australia. New Zealand, however, while apparently near Australia on account of the manner in which our atlases include it with Australia in a single map, is in reality further from Australia than the Mediterranean is from us, and stands apart from the Australian system, although democracy is developing itself in New Zealand upon somewhat the same lines as in some of the Australian colonies. Tasmania, in spite of her growing resources, need not perhaps be separately dealt with; and Australia may be taken as the title for all the South Sea colonies possessing responsible institutions, except New Zealand. The revenue of New Zealand grew in fifty years from *nil* to £4,250,000 sterling. Although New Zealand raises £1,000,000 a year in gold, yet her prosperity cannot be said to have depended at any time on her gold production. She has the most valuable stores of coal in the southern half of the globe, and is fortunate in the possession of coal of a description which can compete with the coal for steamships of South Wales. Her exports of Colonial produce in fifty years grew from *nil* to £9,500,000 sterling a year, and her imports in the same time to £6,500,000 sterling; while her trade is chiefly done in the United Kingdom. She has, moreover, 2,200 miles of railway: an extraordinary advance in these respects for a colony which stands alone in the South Seas.

There is one startling difference between New Zealand and the Australian colonies. Generally speaking, in the latter, from one-third to one-half of the population live in the capital and its suburbs, that is virtually in a single town. Wellington, however, the capital of New Zealand, chosen for its geographical position when the provincial system broke down, is not the most populous city in New Zealand; and Auckland, Christchurch, and Dunedin all contain a larger population. In England we should be inclined to think this a happy circumstance, but a school of philosophers has sprung up in Australia which declares that it is an advantage to the country to concentrate in one city, with the intellectual, educational, and recreational appliances that it can present, all that part of the population which is not tied to a particular part of the country as its residence.

The newer colonies, as yet the least populous, are gaining in Australasia upon the older New South Wales from which they have been successively detached, and upon Victoria which rushed ahead in the middle years of the Queen's reign on account of gold discoveries. Gold is now bringing up Western Australia, the last of them to receive responsible institutions, to a population which will enable her to enter confederation upon more equal terms than could till recently have been hoped.

The rapid development of Australasia in the Queen's reign has undoubtedly been largely due to the rush of diggers from California and of emigrants from the United Kingdom to Victoria, which took place on the gold discoveries in the childhood of some of us. Those of us who are old enough can remember the days before the Crimean war, when the emigrant songs of "Cheer, boys, cheer!" and "Far, afar, upon the sea," were heard throughout the land, and when all the adventurous spirits of the country flocked to the paradise in the South Seas. The push was given in this way, and the deep veins of Victoria and the surface gold of the west coast of New Zealand, and the discoveries of minerals in Queensland, in Tasmania, and in South Australia kept the population in the neighbourhood, while recently Western Australia has again drawn the floating element from the other colonies. If, however, we exclude the gold, Australia will be seen to have made an extraordinary advance; and the great fortunes of Australia have not been amassed in gold, but in land and sheep. Victoria is so limited in her territory, for a colony, that she can hardly hope long to preserve the second place in population; the first being still occupied by New South Wales. New South Wales has, for many years, exported over £20,000,000 sterling in value of produce every year, of which half is wool; and she imports £6,000,000 sterling worth of goods from the United Kingdom. Victoria exports over £14,000,000 sterling worth of produce, of which one-third is wool, and imports £5,500,000 sterling worth of goods from the United Kingdom. New Zealand exports between £9,000,000 and £10,000,000 sterling worth of produce, all her own, as she has no transit trade, and imports from the United Kingdom from £4,000,000 to £4,500,000 sterling worth of our produce every year. Queensland exports £9,000,000 sterling worth of produce, and imports over £2,000,000 sterling worth of our goods. South Australia exports £7,000,000 or £8,000,000 sterling worth of produce, and imports nearly £2,000,000 sterling worth of our goods. Tasmania exports £1,500,000 sterling worth of produce, and imports nearly £500,000 sterling worth of our goods; while the figures for Western Australia are useless, on account of the extraordinary present rapidity of her growth. All this has to be compared with a trade which at the time of the Queen's accession can hardly be said to have been in existence, as it is doubtful whether there would have been a trade from Australia to the United Kingdom, except for the artificial stimulus which was given to a little wool production by the presence of considerable British establishments in Tasmania and New South Wales.

Next after the unparalleled growth of British shipping, and the spread of the English tongue in half the world, the chief phenomenon of the Queen's reign is this Australasian expansion in the wilderness of communities of an intensely British type.

DISCUSSION.

Mr. J. F. Hogan, M.P., thanked Sir Charles Dilke for the very admirable survey he had given of Colonial progress during the reign of Queen Victoria. All members of Parliament knew Sir Charles Dilke as a most accomplished and versatile statesman, competent to speak on any subject which came before the House, but he believed he was only interpreting Sir Charles's own feelings when he said that the subject of the Colonies was nearest to his heart. It was his classical book on "Greater Britain" that first brought him to the front and established his reputation as a well-informed authority on colonial affairs and a rising statesman, and he remembered the delight when thirty years ago as a schoolboy at the other end of the world he read that book. He hoped the author would signalise the present historic year by bringing it up-to-date and issuing a new edition, or else expanding the present paper into a book on Colonial progress during the present reign. He also hoped, when the time came for a change of Government, that he should have the pleasure of seeing Sir Charles Dilke occupying a seat on the Treasury bench as Secretary of State for the Colonies, and of pestering him with questions on Colonial affairs. In the admirable historical survey he had given, no mention was made of the one instance in which a colony had been almost wiped out, viz., St. Helena. At the beginning of the reign, eminent Generals and Admirals looked to the Governorship of that colony as something in the nature of the blue ribbon of Colonial service, and it was then the regular place of call for all ships going to and coming from India, the East, and Australia — in fact it lived upon them; but all that had been changed by the Suez Canal, and the last report from the Governor-General of St. Helena was about the most melancholy document he had ever perused. He thought the Imperial Government should come to the assistance of St. Helena, in view of the strategical importance it would assume in the event of a European war. He was very glad to hear the eulogium passed on the French Canadians, having visited that colony in the recess, and had the pleasure of an interview with Mr. Laurier, the first premier of the old French Canadian race. As an old Australian also, he was much pleased at the allusion to the Australian colonies, but though he joined in the hope that these colonies would become federated during the present reign, he was hardly sanguine enough to expect it. Having lived there the greater part of his life, the impression he had derived was that, up to the present, federation was a statesman's question, and had not yet touched the heart of the people. Federation was generally the result of the pressure of some outward necessity. It was so with the United States and with Canada, and hitherto there had been no such pressure on the Australian colonies. It implied a certain amount of sacrifice and loss of status on the part of the individual colonies, which he feared they were not all at present prepared to undergo. There was something looming in that direction in the recent advance of Japan as a naval power, she being only five or six days from Australia, and there were some symptons of a Japanese bogey taking the place of the Russian one which formerly existed. Some time ago there was an apprehension that a Russian man-of-war might suddenly come down and capture Sydney or Melbourne, but now the bogey was Japan. He did not think there was any immediate danger of that, but he feared that federation would not come just yet. It was a good subject to orate upon at banquets and public gatherings. When he was last out there he addressed a number of meetings in Melbourne, but his impression was that there was not yet any deep-seated sentiment on the question.

The following letter from Sir Charles Kennedy, K.C.M.G., C.B., was read by the Secretary of the Section:—I have been kept indoors the last fortnight by a severe chill, and I much regret that it will not be possible for me to be present at the meeting of the Foreign and Colonial Section on the 2nd of February. It was my wish to have expressed to Sir Charles Dilke the thanks of the Society of Arts for having consented to inaugurate by his address the meetings of this Section for the present Session. His work, "Greater Britain," was an epoch marking publication. It first brought home to the people of this country the aspirations and prospects of the self-governing colonies, and their true position as new communities in different quarters of the world. "Greater Britain" prepared the way for Sir John Seeley's works; and for the action of those persons and public bodies whose exertions have consolidated the good relations which now so happily subsist between the mother country and her colonies and foreign possessions. These results will remain among the most memorable events of the Queen's reign; and the services thus rendered by Sir Charles Dilke possess very great value for the highest interests of the whole Empire.

The CHAIRMAN said he quite agreed with Mr. Hogan in pressing on Sir Charles Dilke the desirability of bringing "Greater Britain" up-to-date. The present paper was of very great interest, and one or two points in it he should like especially to notice. When listening to what was said about Ceylon, he asked himself to what was it due, that the circumstances which might have ruined an important island, eventually resulted in its present great prosperity? It was entirely owing to individual effort, and that was one of the great lessons which the expansion during the last sixty years must have taught the people of this country. It was not the Government but the individual efforts of the people who had gone out, which made the colonies. And going on from that they came to what was perhaps, another secret of the success, viz., that Governments had wisely determined that, as they could not make a colony prosperous, when they found a colony prospering to say to the people, being our own kith and kin, govern yourselves as best you can, and we will protect you to the best of our ability. That at any rate had been the secret of the success of our Australian colonies. There was another important point. In dealing with Canada Sir Charles Dilke pointed out, that the unfortunate struggle which took place over sixty years ago, was due to the attempt by this country to force our laws and language upon the inhabitants of Canada, who did not desire those blessings. The struggle took place and England proved victorious, but he very wisely decided that having won on the field of battle, to concede the principles for which the people had been struggling. That again, was one of the reasons why our colonial empire had progressed, for we virtually carried the people with us; and he felt certain that the day would never come when statesmen would endeavour to govern the colonies according to their own views, but on the contrary they would study to the utmost the views of their inhabitants. He did not think the prosperity of the Australian colonies could be entirely attributed to the gold discoveries. No doubt they were of great importance in increasing the population, and without population colonies could not develop, but on the other hand the granting of self-government had been one of the greatest blessings. The material progress of the colonies had been very remarkable, but he should have liked Sir Charles to have touched a little on other forms of progress which were very noticeable, partly in Canada and Australia, viz., those which made a community powerful for good towards its own people, self-reliant, and respected. In those two great quarters of the world there had been an immense development in that direction; they would find there all the proofs of civilisation, and a readiness to look forward to greater development. Some people found fault with those who had had to do with the government of affairs in Australia on the ground that they had been a little too previous with regard to some of their undertakings, but he thought a little calm reflection would show that such a criticism was not well founded. Those who had the management of affairs there had before them the example of this country, and it was not too much to say that if the present London County Council had had the laying out of the Strand, they would not have allowed such a narrow street to be made. The same with regard to many public buildings, which had been made too small to allow for development in future years. It was no wonder, therefore, that those who had had the government of great towns like Sydney, Melbourne, Adelaide, or Ottawa, should have had before them the serious inconveniences which too narrow a view of the future had produced in this country, and had decided to prepare for a brilliant future. He believed the time would come when people would say, that instead of being too magnificent in their views they had perhaps not been magnificent enough. He was not quite sure that Sir Charles Dilke was right in his remarks with regard to the anti-slavery feeling. There might perhaps be one or two places in the colonial territory where there might be said to be a desire to employ coloured labour, but he felt sure that the great mass of the population, at any rate of Australia, were clear and decided that nothing should induce them to favour slavery in any shape. He heard with very great pleasure the suggestion for establishing direct telegraphic communication between all parts of the empire. If they wished to maintain a close connection with every part of the empire, some expenditure of money and enterprise must be made to secure it. Nowadays, people were not satisfied unless they knew within a few minutes what happened in every part of the world; but it was not merely for the dissemination of news that cables were required, but also for purposes of commerce, and especially of defence; and he trusted what had been said on this head would be noted by those who had the means of carrying out matters of this kind. He trusted there would always be found men like Sir Charles Dilke, who not only knew a great deal about the colonies, but were prepared to take the trouble of instructing others about them, and were not afraid of saying distinctly what they thought on these matters.

Major NEILD (Member of the Legislative Assembly of New South Wales), as an old colonist, having left the mother country in the year 1853, said he felt he should be wanting in courtesy and in common justice if he refrained from taking advantage of the opportunity to express, as far as it was possible for one man to speak on behalf of others, his abundant thanks to Sir Charles Dilke for his eminently able and useful address on a subject of so much importance to all portions of the British Empire. He did not, perhaps, agree, with all the conclusions which he had rather touched upon than explained, but possibly if these points had been fully dealt with, he might not see any ground for disagreement. Perhaps he did not quite gather what was said as to the state of feeling in some portions of Australia with reference to social or socialistic developments. New South Wales was referred to very briefly, and it appeared to him that Sir Charles Dilke was under the impression that in that colony there was more or less of a development of a socialistic type in connection with legislation.

Sir **CHARLES DILKE** said the only statement in the paper with reference to New South Wales was that it had seen for some years a conflict between different tendencies.

Major **NEILD** said there had been in several of the colonies, and strongly in New South Wales, a disposition on the part of the workers, not only to claim, but to obtain the control of political power, and this had been very pronounced in Queensland, but there politicians of all sorts uniting together had turned the course of political development more in a Conservative direction than it had for some little time taken, and he believed the next development which would be witnessed in New South Wales would be something of the same sort. The labouring classes had for a time rather taken charge of the ship of state; but after all, these labour developments, largely socialistic in their type, had succeeded to but a small extent in altering the character of the legislation. The labour members were happy in the thought that they had accomplished a great deal, but he was inclined to think that if the fiscal question were happily out of the way, there would be a distinct development of a more Conservative type in New South Wales. One point must be borne in mind in discussing the colonies of the Crown, that however great their numerical development and commercial progress, and however great the wealth they might amass, whatever might be said to the contrary by hysterical persons occasionally, the heart of the people of the British colonies beat as loyally and as patriotically on behalf of the whole mighty and glorious British realm as it did in the very heart of Empire itself in London. In some ways Australia was if possible more intensely loyal than England herself. The birthdays of the Sovereign and of the Heir Apparent were statute holidays throughout all the colonies of Australia, and although there was no Lord Mayor's procession, they were as completely free from the cares of business on that particular day as the most enthusiastic Londoner could possibly be, because being the birthday of the Heir Apparent, it was kept religiously not only as a statute holiday, but with the hearty goodwill and strong love of the people. It was in that strong love of the people of the British colonies for the centre of the Empire, or the mother country, that were to be found some of the most interesting developments of the great British colonies. He desired most strongly to endorse the remark made by Sir Charles Dilke in the opening of his paper when he referred to their distinguished Chairman as a successful British governor. He had lived under the sway of something like fifteen or sixteen viceregal representatives, not only in New South Wales, but for some years in New Zealand, and was fairly well qualified to judge of the success achieved by a colonial governor, and he was perfectly warranted in saying that no portion of the Australasian colonies ever possessed in its governor a more kindly man, a more capable high official of State, or a more courteous English gentleman, than New South Wales did in the Earl of Jersey.

Mr. **SPENSER WILKINSON** said he should like to say a few words in the form of a question in anticipation of Sir Charles Dilke's reply. He was always in doubt whether most to admire the encyclopedic knowledge of Greater Britain, which Sir Charles Dilke constantly displayed, or the very judicious reserve with which he shrank from committing himself to any general conclusions going beyond that which was absolutely justified by the facts, and after listening to this delightful paper he felt some regret he did not bring his conclusions into one or two more concise general statements with regard to certain subjects which interested them all. It was impossible for any citizen of the Empire to listen to this review of sixty years progress without turning his thoughts forward to some extent, and it seemed to him that in looking forward their minds were occupied with a question upon which he noticed Sir Charles quoted from Montgomery Martin, the connection between our maritime power and the Empire, and with that other question which the last speaker had mentioned, the sentiment of unity and loyalty which pervaded the whole of our colonies. He hoped Sir Charles would not let them go away without saying a word or two of forecast or suggestion as to his hopes with regard to the way in which that sentiment of Imperial unity might be sustained and expanded, and with regard to the manner in which the policy of this country might contribute towards it. He had been struck for many years with the way in which all who discussed the subject of Imperial unity looked to some method of political organisation as the outcome, and seemed apt to suppose that practical expression could be given to the feeling of unity amongst the whole British race by various methods of political organisation rather than by action on the part of the mother country tending to promote that feeling of unity. The idea for a long time was that the British Government was to be strengthened by relying on the Colonies for assistance in defence, but had they not come to the time when that view should be reversed, and they should say that nothing would more strongly develop the sentiment of unity in the Colonies than decided action by the mother country in the sense that she intended to maintain her position in the world as the head of the union in which they lived. As a corollary to that he would add this. At the time the survey began and for many years afterwards might it not be said that the civilised world could fairly be regarded as divided into two halves, one containing the growing British Empire under the protection of British maritime power, and the other composed of Europe and the United States, which were at the time accustomed to suppose that they had no part in the rest of the world, which was the sphere for British colonisation. Had not that view which was unconsciously adopted for many years, and which other powers accepted, been transformed during the last fifteen years by the growth of an interest among all other civilised powers such as they had not possessed before in the process of colony creation, and was there not now a great danger, in view of that feeling, that our monopoly, such as it was, was not any longer to be tolerated, and a great difficulty confronting British policy in the maintenance of British unity, so that we had to choose between the attempt to maintain our maritime supremacy, and the necessity to come to terms with the other civilised powers as to how far they should take their share in the creation of new colonies.

Mr. SPENCER TODD said he rose with diffidence, but must say a few words because the remark made in the paper that the sentiment against slavery had lessened since 1838 was followed very closely by attention being drawn to an alteration in the franchise law at the Cape of Good Hope, and the two seemed to be thus connected. Now he had for many years been a returning officer and a registration officer there, and knew the operation of the franchise law as it formerly stood. It practically came to this, that if any man wished to register a number of coloured people he got them to make marks on a claim, not by the score, but by the hundred, and no one taking the trouble to object formally, the magistrate was compelled to register them. Then, when it came to to an election, this man simply had 600 votes in his pocket. The returning and polling officers could not tell whether this was really Michael Jonas or Piet Klaas, for if they had gone into a neighbouring district for any purpose there were always substitutes, but no means of identification. The recent Act which applies to a country where the native races far outnumber the white was designed a good deal to meet such abuses. The new law requires a man to show his ability to write his name and address and his individual right to register and to vote, and that makes a very considerable difference at mission stations, and native locations, where previously men had simply voted on the joint tribal tenures, whereas if you divided the proposal by £25 or £50, as in the case of every white man, the great majority of these natives would never have had a vote. The coloured man is now really in the same position as the white man; there is an educational qualification, he signs his name, and you can identify him. I am quite sure that neither Dutch nor English attempt in any part of the British colonies of South Africa to countenance a return to slavery. There is the greatest horror of anything of the kind. Just as in Canada and in Australia, loyalty is much more demonstrative and marked in South Africa than even here in London. It is not uncommon here for people to remain covered when the national anthem is played, but such a thing is totally unknown at the Cape. There, a so-called "Dutch Boer" would remove his hat at the mere mention of Her Majesty's name, and even if he could speak little English would cry out "God bless her."

A vote of thanks to the reader of the paper having been carried unanimously,

Sir CHARLES DILKE, in reply, said he would not deal at length with Mr. Spencer Todd's remarks, but the connection in the same paragraph of a reference to the reconstruction of the franchise at the Cape, and the diminution in the anti-slavery feeling in this country and the British Empire, was rather accidental than immediately dependent. He held strong opinions on the general question of the protection of the native races, and thought that we had gone backwards on that question. He did not think we stood so well on it as in 1837, which was the very year of the sitting of the famous Parliamentary Committee which considered the whole of that question, and the report of which, said to have been written by Mr. Gladstone, was marked by an elevation of language which might be taken as a text at the present time. He had referred to his own purely personal view with regard to the Glen Grey Act, which he personally disapproved of, and the reference to the franchise was one which he said would be the subject of dispute as regards the alleged facts. He was aware of the abuse of the registration system with regard to native voters, and had heard stories which went beyond those Mr. Todd had related. The difficulties of registration in some Welsh counties, where the whole of the people were called John Jones, were undoubtedly great, but those of the districts in the Cape, where the whole of the natives were either Peter or Paul, and had no surnames at all, were greater still. One of these stories went so far as to relate the registration of a herd of sixteen bullocks as voters, who did not actually poll, but might have been personated. Mr. Hogan's activity on colonial questions in the House of Commons made him a little nervous of answering his questions for fear of trenching on the prerogative of Mr. Chamberlain. With regard to St. Helena, it was not every day that we had a Napoleon Bonaparte to shut up in our island, and although he had been dead a good while when the Queen came to the throne, still St. Helena to some extent lived on his memory. All ships returning from India used to call there in order that all the old ladies in this country might be provided with locks of his hair and sprigs from the weeping willow that overhung his grave. It was no doubt the case that St. Helena played a far greater part in the days when all the traffic went round the Cape than it could at present; and they could not very well desire to see its prosperity return, because as it appeared to him that could only arise from our being involved in a great war. Then it would revive, but probably nothing else would do it. With regard to cable communication which was mentioned by Lord Jersey, he attached the utmost importance to its being British communication in British hands through all parts of the Empire, especially along the Cape route. Undoubtedly in time of war the great bulk of trade would have to be on that line to the East, and at the present moment we had not even telegraphic communication of our own to Gibraltar, to Malta, or to Sierra Leone, nor even any of those links with either Gibraltar or Sierra Leone. All the lines touched on Portuguese, French, or other foreign territory. Although it might be the case that there would be a risk in time of war, that all the cables would be dragged up and cut, was not so certain as some supposed. Telegraphic lines could not be cut in all parts of the world, only where the enemy had a pretty clear sea before them. The same patrol which protected the trade route would protect the cable, and even if one bit were cut the other bits would still be of the greatest possible utility. Mr. Hogan and Lord Jersey had both asked him to bring "Greater Britain" up to date. He tried to do it once, and the attempt to do it was somewhat of a failure, for the British colonies grew so fast that to write an account of them as they stood at any particular time was a proceeding which involved an enormous amount of labour, and when you had finished you were already out of date. When he wrote the book called "Problems of Greater Britain" in 1890, he attempted to do that which Mr. Hogan suggested, but the old book went on with a perennial sale, whereas the new book was long since out of date. No doubt an expansion of the theme of which he had been speaking that night—of the progress of the British Empire during the Queen's reign—might be done if someone had the time to do it, and it had already been done in some detail as regarded various colonies by some writers like Mr. Greswell and others he had named, but that was not exactly the same thing. He must express his appreciation of the warm tone of Sir Charles Kennedy's letter. It was at his wish that he came that evening, and he believed also that Lord Jersey was asked to occupy the chair, and he knew the regret it must have been to him not to be present at the inaugural meeting of the series to which he attached so much importance. Major Neild, speaking as a colonist from New South Wales, raised a point with regard to its domestic policy which he ventured to answer at the moment. It was the colony of New Zealand which was going most rapidly ahead with experimental legislation. He did not blame that in any way, and in making use of the term socialistic tendencies to Australasian legislation generally he was rather holding it up as an example of a gratifying amount of enterprise in the legislative field to be respected and admired than the reverse. They ought to be glad when Australia took the lead in trying experiments of this nature, as should be done in very many directions with the best possible results. She initiated the system of ballot election, which was exactly imitated by ourselves. She made experiments in national education and in factory and shop legislation which had been followed by ourselves, and there was no doubt that Australia had got into the habit of leading the way in taking many steps which afterwards we found it prudent to follow. In speaking of socialistic tendencies one could not but be deeply struck by the difference of tone (existing more in the case of the other Australian Colonies than it did in New South Wales) and in Canada. Undoubtedly in Canada you had as you had in the United States an absolute individualistic frame of mind. They regarded that state of socialism and all steps in that direction with much more horror and dismay than we did even in the mother country. On the other hand, it was undoubted taking the case of Australia, though less marked in New South Wales than in the other colonies, there was less horror of experiments in that direction than in Canada and the United States. Mr. Spenser Wilkinson put some questions which it would take a long time to deal with at the length their importance deserved. He spoke of the colonies in regard to imperial defence, and hinted at the question rather than actually asked it, as to his advice with regard to the character of the connection between the colonies and the mother country. He thought himself that the allusions to that subject made the other day in a speech by the Duke of Devonshire were very wise and prudent, and no doubt they were made on behalf of the Government. Mr. Wilkinson had done much himself in his various books to bring forward the consideration of that subject; and he was glad to say that, when the Duke of Devonshire referred to it as he did the other day, he showed that the Government had to some extent assimilated a good deal of Mr. Wilkinson's own teaching. They must all desire if it could be brought about without any dangerous straining of allegiance, and without imposing any risks on the existing strength of the connection between the mother country and the colonies, that they should gradually come to take their share in the defence of the Empire. But all would desire not to press that on their consideration in such a way as to weaken the present connection, or to arouse any feeling of dissatisfaction. Possibly the time might come when a further conference on this question might take place to advantage. An invitation had lately been addressed to the Prime Ministers of the colonies to visit England during the present year, and possibly some good might come out of that meeting. He did not believe in the possibility of anything like imperial councils of defence, or in any close union for defensive purposes, where all parts of the union were to be consulted as to every step to be taken. The difficulties of bringing people together from long distances, or arriving at a wise decision by means of the telegraph; the necessity in all matters of war, and all matters which looked towards war, of having a single mind at the head of events, were so great that anything like a council was abhorrent to his mind, but that the colonists should be brought to a desire to take their place in connection with the mother country in a general scheme of defence, they must all desire. The Australian colonies already did a good deal in that direction. As matters stood they were safe from anything like invasion on a serious or heavy scale, but they were not in a position to play their part in a warfare outside their own country. The time might come when the Australian colonies might feel that they were so deeply interested in the preservation of the unity of the Empire that they would be prepared to go somewhat further, and to say that they recognised the importance of the continuance of British rule in India, and be prepared in certain eventualities to contribute towards the expense of it. This agreement could only be brought about slowly, step by step. He agreed with what fell from Mr. Wilkinson, that our unquestioned naval supremacy must lie at the foundation of the whole question. That was necessary for all these purposes. It was a necessity to secure Australia against invasion, and to secure India for our rule, although, in that case, it was not the only necessity. Mr. Wilkinson opened some very important but large considerations on the second of his two questions. Foreign competitors had come late into the colonial field, and all portions of the globe where there was a chance of Europeans bringing up white children in health had been swallowed up by ourselves and by those who had gone to portions of South America. Coming late into the field they had been driven into unhealthy districts. The German colonies were almost all established in districts which were called colonies of plantation, not inhabitancy. Those in Africa were almost all of them in the bad health field, except Demaraland and Namaqualand. That had a poor coast, and the interior behind was not very valuable. That was not the case with France. She had acquired colonies, especially recently in Tonquin, of a more valuable type. No doubt it was a perpetual cause of irritation to Germany that she should find herself with colonies which did not properly pay their way, and that must continue to lead to a certain amount of national jealousy and irritation expressed in ways which might be painful, but that could not lead to any stoppage in our proceedings with regard to our own colonies. We were not for various reasons the most popular of powers, but that could only make us more auxious to hold our own and to protect ourselves in our own way by making our own naval supremacy complete and secure. That was the foundation of our Empire and our only security as regards the future. He believed it was far wiser for the people of this country to do that which they could afford to do, namely, to pay for naval defence than to embarrass their policy by engaging in alliances which after all were not likely to give them the protection they wanted, but these considerations would lead them somewhat beyond the present purpose. In conclusion, he begged to thank Lord Jersey for taking the chair. He was not only a successful Governor of New South Wales, but was chosen by the party to which he did not belong, to represent Her Majesty at the last great Colonial Conference, and did so under very difficult circumstances. The questions raised were very difficult, and involved the free trade policy of this country, and there were sharp struggles between the delegates from some of the colonies as regarded the particular class of suggestions made. Lord Jersey there made a series of speeches, which were full of tact and ability, which he read with the greatest possible admiration, and preserved as models of the style of dealing with a very difficult question, which no man could have dealt with more completely.

NINTH ORDINARY MEETING.

Wednesday, February 10, 1897; Sir STEUART COLVIN BAYLEY, K.C.S.I., C.I.E., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Barnett, Walter George, Great Indian Peninsular Railway, Sholapur, Deccan, India.
Grey, Arthur Ernest, 13, Spencer-street, Clerkenwell, E.C., and 20, Canonbury-villas, Canonbury-road, N.
Rex, Francis Herbert, 311, Kentish Town-rd., N.W.

The following candidates were balloted for and duly elected members of the Society:—

Ellis, William Frederick Wood, Bombay, India.
Heimpel, J., Dindigul, Southern India.
Powell, James Crofts, Whitefriars Glass Works, 26, Tudor-street, E.C.
Sewell, John, 199, Victoria-street, S.W.
Tennant, Hon. Sir David, K.C.M.G., 112, Victoria-street, S.W.
Weaver, H. J., Guildhall, Gloucester.
Whittuck, Edward Arthur, M.A., B.C.L., 77, South Audley-street, W.

The CHAIRMAN, in introducing Mr. Crole, said that besides being a distinguished chemist, he had a practical knowledge of tea from having been a planter in Assam for six years, and the meeting could not fail to be interested in the paper.

The paper read was—

THE CHEMISTRY OF TEA.*

BY DAVID CROLE.

When an industry like the cultivation and manufacture of tea is in its infancy, its pioneers are usually content to base their work upon a series of empirical rules founded on their own practical experience; and this rule-of-thumb system generally obtains for such a time as lack of competition, &c., will allow. However, there comes a time, sooner or later, when either the inquisitiveness of the chemist or the necessity, incidental to keen competition, of finding other and improved methods causes experimental inquiry to be set on foot, and then discoveries are made which, either all at once or else slowly and step by step, alter it may be the whole system previously obtaining. With tea the advancement of knowledge has been chiefly in practical lines, and science has been speaking broadly till the present decade, very little requisitioned to help in the evolution of a more perfect system of cultivation and manufacture. This is a fact that is much to be deprecated in the light of the large amount of help that we know chemistry and kindred sciences have bestowed on other products. It is to direct more general attention towards and stimulate research into the matter that the present paper is being read. When the chemistry of a vegetable product such as tea is the subject treated of, it will be found that we must trespass on the neighbouring realm of botany in order that we may start with a knowledge of how, and when, and where the substances that are to be dealt with are formed in the first place. For this reason the following short description of the elaboration of the various chemical constituents within the tea plant is given as a fitting introduction to the discussion of the substances themselves later on.

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To begin with, however, it must be explained that we are not precisely conversant with what exactly goes on in the interior of plants; and thus many details, which would prove of practical importance, are as yet lost to the tea planter. However, this much we do know, that protoplasm, or cell substance—a most complicated organic compound, consisting of C, H, O, N, S, Fe, and often phosphorus also—is the first substance formed in plant life, and it arises from carbonic anhydride (CO_2), water, nitrates, &c., these substances constituting plant food. In the structure of leaves there are special cells (chlorophyll cells), whose function it is, together with sunlight, to split up the carbonic anhydride into its elements. It has not yet been clearly made out what is the exact part played by chlorophyll in this reaction, but it is supposed that it absorbs certain rays of light (while excluding others), and that this enables such protoplasmic matter as it is intimately associated with to utilise the radiant energy derived from the sunlight for the construction of various organic substances, containing carbon, hydrogen, oxygen, and nitrogen (obtained from CO_2, water, and ammonia). Thus, then, the progressive decomposition of protoplasm, carbonic anhydride, ammonia, &c., and complicated reactions between their products, ultimately furnish us with the chemical substances that we find in tea. It has just been remarked that chlorophyll and light split up the CO_2 absorbed by the plant into its elements; this, of course, they do not accomplish all at once, but, on the contrary, there are probably many stages in the process of reduction or deoxidation. The intermediate compounds then, it may be supposed, act and react with one another, and with the other substances just mentioned; so that, in the end, we have recognisable compounds formed, which are classified as nitrogenous and non-nitrogenous bodies. It may be mentioned that about the first recognisable product is starch, which is usually converted into a soluble form (sugar) for convenience of transport, either to the growing points, where it is converted into cellulose or else to the roots (in turnips, &c.), where it is converted into starch for reserve storage.

And so having glanced at the origin of the substances found in tea, we will plunge at once in *medias res* and examine what these substances are, and discuss their properties and uses whenever it appears of interest.

A glance at the Table on page 212, of the analysis of various teas, which, I may mention, I have borrowed from "Tea: a Text-book of its Cultivation and Manufacture," a book published by Messrs. Crosby Lockwood and Son, which I have lately written, will show that the chief substances found in tea have been classified under (1) non-nitrogenous, (2) nitrogenous, and (3) inorganic bodies, the two first divisions being organic substances.

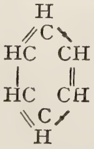
As this Table comprises rather a formidable list of substances, I feel I can trespass neither on the time nor on the forbearance of my audience to the extent of discanting in detail on every one of these constituents. The subject being such a large one, only the most important points can be dealt with in the circumscribed limits of a paper. However, those who care to learn more about tea, either with regard to its chemistry or any other point connected with it, can, I think, satisfy their curiosity by consulting my book, which fully treats of every detail connected with tea.

THE PROXIMATE CONSTITUENTS OF TEA.

		Assam.	Ceylon.	Java.	China.	Japan.	Natal.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Non-Nitrogenous Bodies :—							
Organic acids.	Gallic and oxalic acids, &c.	1	·65	·50	·25	·25	·50
	Tannic acid	11 to 18	15	14	12 to 20	12 to 16	10 to 14
	Boheic (Assamic) acid	1·50 to 2·5	1·75	1·50	1	1·25	1·25
Carbo-hydrates.	Cellulose	18	20	22	25	22 to 26·5	24
	Gum and dextrine	2·75	2·5	3	3·25	3·25	2·75
	Glucose	trace	—	trace	—	—	trace
	Mucilage, pectin, &c.	9·75	5·5	6·5	7·2	6·7	7
	Resins, &c.	2	3·75	3·25	3·25	3·5	2·75
	Fixed Oil and Theol (volatile essential oil)	·7 to ·9	·6	·55	·4 to ·5	·5	·6
	Gums and Waxes	3·75	4·25	4	4·25	4·50	4·2
Nitrogenous Bodies :—							
	Chlorophyll	1·8 to 3	1·5 to 2·5	1·25 to 2	1 to 2·2	1·8 to 2	1 to 2
	Amides	traces	traces	traces	traces	traces	traces
	Theine	3 to 6	2 to 4·5	3	1·5 to 2·25	1 to 2·5	3·7
	Other Alkaloids	traces	traces	traces	traces	traces	traces
	Albuminoids	20	22	20	21·5	20	21·7
Inorganic Bodies :—							
	Mineral substances	4·5	5·6	5·5	6·7	6·5	5·75
	Moisture	6 to 8	8·5 to 10	6 to 12	8 to 16	12	8 to 11

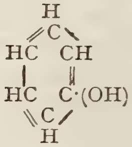
Amongst the *Non-Nitrogenous Bodies*, we have some *Organic Acids*. These always contain the carboxyl group (COOH). Those found in tea are tannic, gallic, and "boheic" acids, with traces of oxalic and other acids. To understand the relations between tannic and gallic acids and various kindred vegetable products such as phloroglucin, &c., it will be necessary to represent a series of benzene compounds by graphical formulæ.

Benzene (C_6H_6), the first member of the fifth homologous series of hydrocarbons, is represented by six carbon atoms, each with a hydrogen atom attached, arranged in a ring thus :—



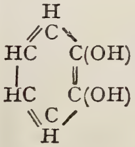
I may mention *en passant* that this "ring formation" is characteristic of the benzene group of derivatives.

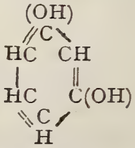
Now, if we replace one hydrogen atom by the hydroxyl (OH) group we shall get phenol or mono-hydroxy-benzene, C_6H_5 (OH) or—

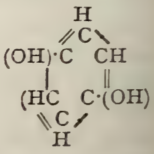


A glance will show that it is a matter of indifference to which carbon atom the hydroxyl group is attached. Phenol is popularly called carbolic acid, but it will be noticed that neither phenol nor pyrogallol contain the organic acid group (CO OH), and therefore are not acids at all, but alcohols.

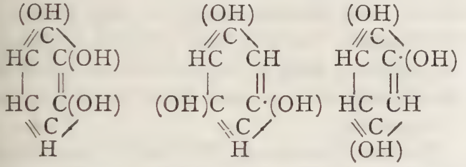
Next, suppose that we wish to make a dihydroxy-benzene, it will be perceived that there are three ways of accomplishing this, thus :—







Therefore we may expect to find three substances with the formula $C_6H_4(OH)_2$ and as a matter of fact three, and three only, such compounds are known, the first being called ortho-, the second meta-, and the third para-di-hydroxy-benzene, the last-named is also known as hydroquinone and is used in photography and medicine, the second is also known as resorcin and the first as pyrocatechol. All these either arise in plants or can be got from plant products. It will be as well to explain at this point that such substances as have the same per-centage composition are called isomerides, and they are of two kinds, viz. :—(1) *Metameric* bodies, which have the same molecular weight, such as the substances just mentioned, whereas (2) *polymeric* bodies, such as members of any hydrocarbon series, have different molecular weights (*e.g.*, quintone C_5H_6, and decone $C_{10}H_{12}$). Let us continue our substitution of hydroxyl for hydrogen, by turning out a third atom of hydrogen, so as to form tri-hydroxy-benzene $C_6H_3(OH)_3$. We shall find that only three isomers can be obtained, viz. :



These three compounds have been styled "consecutive," "symmetrical," and "unsymmetrical" tri-hydroxy-benzene respectively, and the reason for such nomenclature is obvious, on studying the above formulæ. These isomers can also be obtained from plants. The first is also known as pyrogallol, the second as phloroglucin, and the third as oxyhydroquinone. Pyrogallol is the "pyrogallic acid" of photography, but, as has been already explained, the term is a misnomer. Phloroglucin was discovered by Hlasiwetz over 30 years ago. It results from the action of caustic potash or soda on various resins, or with resorcin, a substance I have just spoken of. It has been supposed that this phloroglucin combines with some of the nascent carbonic anhydride that would otherwise be exhaled by the stomata on the underside of the leaves, and that gallic acid is the result; thus :—

$$C_6H_3(OH)_3 + CO_2 = C_7H_6O_5.$$

If we proceed one step further in our chain of alterations in the hydroxy-benzene series, this time supplanting another atom of hydrogen by the carboxyl or acid-forming group (COOH), we shall get a number of acids, having the formula $C_6H_2.(OH)_3(COOH)$. These are the various gallic acids, and if heated with lime, or even by themselves, carbonic anhydride is evolved and a tri-hydroxy-benzene ($C_6H_3(OH)_3$) results, which may be either pyrogallol, phloroglucin, or oxy-hydroquinone. Ordinary gallic acid, which is obtained from gall nuts, will give, under such treatment, pyrogallol, whereas it would seem that the gallic acid of tea gives rise to phloroglucin, while under other conditions, as has been already mentioned, the converse obtains.

It has been suggested that the tannin of tea arises from the decomposition of the gallic acid, carbonic anyhydride and water being the complemental products. This theory, however, is full of intricacies and is but hypothetical.

Gallic or dioxy-salicylic acid exists in many plants. In tea there is seldom as much as 1 per cent. It is, in part, formed during manufacture by the oxidation of the glucosidal gallo-tannic acid, which re-action will be referred to again when tannin is under discussion. It does not possess the deleterious property of precipitating albumen, gelatine, or starch as tannin does; and since it is just as capable of imparting pungency to tea, it would seem a pity that a great deal more of the tannin is not re-converted into it. I would suggest that experiments be made in tea factories as to the effect of careful regulation of access of air and amount of heat applied during the operation of "firing" the tea, and that means should be tried to regulate the conversion and re-conversion of gallic and tannic acids during the fermentation stage of manufacture. It is obvious that in cases like this, theory can be of little avail beyond suggesting the direction in which practical experiments should be made.

It should be noted that gallic acid gradually decomposes on keeping.

Tannin.—Under this name is included a group of closely allied vegetable acids, each possessing some differential point to warrant its separate identity and individuality. All forms are soluble in both water and alcohol, but are neither volatile nor fusible. They are roughly divided into "iron-blueing" and "iron-greening" varieties, according as to whether the re-action of a particular variety with ferric chloride is a blue or a green one. It is said that "Bohea" tannic acid ($C_7H_{10}O_6$?), the chief form found in black or fermented tea belongs to the latter class, while "tea" tannin, the characteristic form of the acid in green or unfermented tea, falls within the "iron-blueing" class, but the result of my experiments with the tannin found in tea, leads me to say that this is, at any rate, by no means constant. I have generally found the reaction of $Fe_2 Cl_6$ with both black and green teas to be an identical bottle-green one. It would seem, however, that there is more than one representative present in tea, and they are akin to gallo-tannic acid. To tannin the pungency of tea is largely due—a valuable property from the commercial point of view. The origin of tannin in the plant is somewhat difficult to account for, but it would seem that it arises, at any rate in part, from gallic acid, though it must be mentioned that during the manufacture of tea some of it is oxidised back again into gallic acid and glucose by the action of a particular enzyme (pectase). From this last reaction it will be seen that tannin is a glucoside, by which is meant a body which, when acted on by dilute sulphuric acid or an enzyme, yields glucose, &c.

When tea liquor remains in contact with air for some days, a cloudiness is apparent which is due to a reaction between the tannic acid and the legumin and the consequent formation of an insoluble and obscure compound, the astringency of the infusion being of course at the same time decreased to a marked extent. This reaction accounts, in some measure for the "mellowing" of tea that is kept for a time. Freshly manufactured teas produce unpleasant symptoms when drunk, therefore, they should always be allowed to mellow for at least six months.

Lowenthal's method for the estimation of tannin, that is by titration with potassium permanganate, possesses the advantage of simplicity.

A deleterious property of tannin is that it precipitates gelatine, and forms with albuminoid matter compounds closely related to leather.

When the tannin of tea (or any of the tanno-acids) is taken into the system apart from albuminoid material, it is quickly converted during digestion into glucose and gallic acid, the former being an useful food substance, and the latter at any rate less injurious than the original tannin. If, however, the tannin is taken in conjunction with albuminoid matter (as in that horrible meal dear to the hearts of a certain class of English folk and to many Colonials, called a "meat tea"), a leathery compound is very soon formed which takes all the time of a powerful digestion to tackle, and break up into compounds that can be assimilated. In fact, "meat teas," or any other similar combination of albuminoids and tannin, mean dyspepsia

As for the so-called "boheic acid" ($C_7H_8O_5$ 2Ag.), I am of opinion that it is not a definite substance, but is composed of more than one organic acid, or at any rate that "boheic acid" has not been isolated free from other substances intimately united with it.

It is a light yellow substance, highly hygroscopic, and gradually absorbs oxygen from the air. It possesses a slightly bitter taste. Like gallic acid, it adds to the strength and pungency of tea without possessing the deleterious quality of precipitating albuminoid matter.

Any one working on the chemistry of tea gets out an acid or an alkaloid, and incontinently proceeds to give the newly discovered (?) substance a name. However, that is a much easier matter than to identify it with a substance previously got out by another investigator. Hence the separate identity of boheic and assamic acids is very doubtful. As "boheic" acid is very plentiful in Assam tea, Assamic acid would seem to be one of the constituents of, if not identical with, the former acid.

Carbohydrates.—In the case of tea, these consist of cellulose gum, dextrin, and glucose. They are classified under hexatomic alcohols, and are divided into three groups, viz. :—Amyloses, Glucoses, and Saccharoses.

This first group, the amyloses, accounts for one-fifth of the composition of tea, and consists of cellulin, starch and certain gums, and when these are boiled with sulphuric acid they yield first dextrin and then glucose. *Glucose* is present in tea before manufacture in small, though appreciable quantities, and during the fermentation process it is formed to a limited extent by the decomposition of gallo-tannic acid, due to the action of an enzyme (pectase). However, the operation of "firing" the tea immediately follows the fermentation process, and the high temperature employed to accomplish the drying of the tea tends to "caramelise" the glucose, especially when the heat to which it is subjected is above 160°. Caramels are dark substances obtained by heating sugars, but their composition has not been determined.

Glucose (grape sugar) occurs in all fruit. Glucose and dextrin are both constantly present at the growing points of all plants. When starch is heated, brown coloured dextrin is formed. It is soluble, and occurs in germination. The gums of the amylose group have not been properly made out.

The *mucilage* of tea consists of pectin, pectoses, &c., and the thickness of the infusion very largely depends on the amonnt of these substances present. It is soluble in water when heated above 45° C., but on the liquor cooling, partial gelatinisation takes place, which causes in great measure the familiar opacity of the liquor, which is technically known as "thickness of liquor" and "creaming," and is a quality held in high esteem by tea-tasters, and hence, of course, by buyers too.

"Creaming" is also formed by the action of tannin on theine, and this we will speak of later. Pectin and pectoses are carbohydrates got from the juice of ripe fruits. Very little is known about them, except that they are insoluble in alcohol, but soluble in water. Städe, in 1863, described pectose as a lime compound of pectin.

Both classes of oils are found in tea, viz., fixed as well as volatile oil.

Fixed oil, of which there is about ·5 per cent. in tea, unlike volatile oil, does not evaporate on heating, but leaves a grease stain on paper. Fixed oils are alkyl salts, and contain the triad radical glyceryl combined as oleate, stearate, or palmitate. Subjected to a temperature of 200 degrees, they thicken, become dark in colour, and partially decompose ("boiled oil"). The fixed oil of tea seems unable to hold the evanescent theol captive, and experiments might be made with introducing other and better vehicles, such as *ben* oil, &c.

Volatile oils are mostly hydrocarbons, and contain no oxygen. They are slightly soluble in water, and possess a characteristic odour. Their solutions in spirit form "essences." When boiled with potassium hydrate they neither saponify nor yield glycerin. They consist of two parts—(1) solid stearopton, and (2) liquid oleopton; all contain decone ($C_{10}H_{16}$), which is a member of the turpene series of hydrocarbons or some *polymer*, and are obtained by distillation with water.

The amount of essential (volatile) oil in tea, which I have named theol, is variable. It is of great importance, as, though present in such small quantities, yet its odour is so strong that it imparts a major share of the aroma and a certain amount of the flavour to tea. Owing to these volatile properties, tea loses its characteristic delicate aroma if exposed to the air for any length of time. This constituent is developed to a certain extent during withering and also during the first stage of firing. Through irrational firing, however, a good deal of it is driven off mechanically by the steam generated in the firing, or may be in part oxidised into resin. I am rather inclined to think that more than one representative of this class of compounds (viz., volatile oils) is present in tea. To arrive at certain conclusions on such minute, though perhaps important, points would require much time and elaborate work, which unfortunately in this busy age few of us are able to give unless it is actually our business to do so.

I have little doubt that, if proper attention were given to the subject, a very considerable increase in the per-centage of essential oil would result, and the tea consequently would be greatly improved in quality. It could be extracted from refuse tea, &c., by distillation with steam; but the great difficulty in the way is the seeming impossibility in keeping it, as it so readily resinises in contact with air.

Several kinds of resins (some of a glucosidal nature) are found in tea, and are to some extent produced by the oxidation of the essential oil, so it would perhaps be an advantage to prevent this taking place, as the resins are insoluble in water, and therefore have no influence as such, on the strength of the liquor; but it will be readily perceived that the more resin there is, the less essential oil there will be, and *vice versâ*.

Though certain bodies may be *practically* insoluble in water, they may yet dissolve in sufficient quantities to impart an appreciable smell (turpentine, for instance), and even bodies that are quite insoluble in water may be volatile with steam; and I think that some of the aroma of tea is due to these facts.

We will next proceed to discuss the other division of the organic constituents of tea, viz.:—

THE NITROGENOUS BODIES.

Some of these are complex ammonium derivatives, which are classed as amines and amides. The *amines* are basic, ammonia-like bodies, made up of an hydrocarbon group, directly united with "amidogen" (as the radical NH_2 is called); *e.g.*, methylamine CH_3NH_2. *Amides*, on the other hand, are formed by the substitution of amidogen for the hydroxyl radicle (OH) in the carboxyl group (COOH) of an acid; for instance, acetic acid is CH_3COOH, while acetamide is CH_3CONH_2.

Various alkaloids have been discovered in tea, and I am persuaded that yet more will be revealed by future analysis. Some of those that have already been isolated are probably identical, as I have previously remarked. Alkaloids are nitrogenous bodies, some of vegetable and some of animal origin, and they may be defined as complex ammonium derivatives, some resembling amines, while others more closely approach the characters of amides. They possess feeble basic and alkaline properties, and, like ammonium, form additive salts. Alkaloids are usually insoluble, or only slightly soluble in alcohol. Theine, however, appears to be freely soluble in hot water, which is rather exceptional behaviour for an alkaloid. One part of theine is soluble in 75 parts of hot water, Commaille, indeed, asserts in 22 parts of water at 65°, but there would seem to be some error in the statement. Theine and strychnine are stable in strong sulphuric acid, whereas other alkaloids are decomposed by it.

These substances are divided into two divisions, viz., vegetable and animal alkaloids, the latter consisting of ptomaines and creatin, &c. The vegetable alkaloids are divided into three groups, viz., (1) cinchona group, (2) opium group, and (3) an unnamed, but very important, group, containing strychnine, atrophine, aconitine, cocaine, caffeine or theine, theobromine, &c. It is with this last group, therefore, that we have to deal.

It must be borne in mind that alkaloids never exist in plants in a free state, but usually combined in the form of an acid salt of malic or (as in the case of tea) tannic acids.

One of the best methods for estimating the theine in tea is that of Claus. According to it, the powdered leaves are dried and then extracted with ether. The next stage is to dissolve off the solvent and extract the residue with sulphuric acid. The acid liquor is then filtered, mixed with an excess of ignited magnesia, and evaporated to dryness at 100°. Finally the residue is pulverised and extracted with boiling ether.

If an infusion of tea is acidulated with sulphuric acid and agitated with benzene, theine will be extracted, whereas, if chloroform be used instead of benzene, then theobromine will be obtained. Both benzene and chloroform are, of course, practically immiscible with water.

Theobromine can, therefore, be separated from theine by cold benzene, in which the former alkaloid is practically insoluble.

Theine or caffeine is found in various plants, all of which are used as food. It occurs in coffee, tea, guarana, or *Paullinia sorbilis*, in which Martius found 3·9 to 5·05 per cent. of the alkaloid; in mate or yerba (*Ilex Paraguayensis*) 1·85 per cent., in the kola nut (*Sterculia acuminata*) 3·35 per cent., in cocoa ·25 per cent,, and in the leaves of the yopon (*Ilex cassine*), which is a shrub growing on the coast of Virginia and Carolina, where it is used as a beverage. Yopon contains 7·4 per cent. of tannin, ·27 per cent. of theine, and a trace of manganese, which is a characteristic point in the tea plant.

There is good reason to believe that theine is a production of the hydrolysis of a more complex glucosidal body.

The characteristic alkaloid of cocoa is theobromine, but associated with it there always is a trace of theine (as in cocoa, kola, &c.). In tea, a trace of theobromine is also found. Theobromine may be regarded as a lower homologue of theine, and therefore a reason for its constant association with theine suggests itself. Its physiological action is similar to, but more powerful than, theine.

Unlike a large class of alkaloids obtained from plants, theine and theobromine are not related to pyridine and quinoline, but are respectively the di- and tri-methyl derivatives of xanthine ($C_5H_4N_4O_2$).

Xanthine is closely allied to uric acid ($C_5H_4N_4O_3$), and is found in tea. Theophylline and paraxanthine are bases isomeric with theobromine.

Theine has a tonic and stimulant action like quinine, but is not followed by depression, neither does a large dose lower the temperature. It dilates the pupil when applied to the eye. In man the physiological action of theine is (like digitalis, but quicker and better borne) to stimulate the cardiac muscles and thus increase the heart's action; it also excites the nervous system. In an effusion of tea these actions are, however, considerably modified by the tannin, extractive matter, and theol present. When administered in toxic doses to the lower animals (*e.g.*, the cat), theine produces great thirst, increased frequency of the heart's action, violent vomiting, repeated emptying of the bladder and intestines, and tetanus and rigor of the voluntary muscles. Nitro-glycerin and apomorphine have both proved successful antidotes. Theine is used to counteract the alcohol and morphia habits.

The way in which theine and its congeners (theobromine, xanthin, hypoxanthin, guanin, &c., glycocol and ptomaines) behave in the animal economy is as follows:—The primary action is to free the blood of uric acid by preventing the solubility of the latter in the blood, and the immediate results which supervene are due to the circulatory changes thus produced.

This explains the primary stimulating action on the system consequent on the administration of theine, &c. The secondary action is to charge the blood with uric acid, and the subsequent secondary results are due to this fact. This raises an interesting point as to tea, coffee, and cocoa-drinking with patients suffering from uric acid diseases.

Although the isolation of pure theine is perfectly easy, the accurate determination of the per-centage of it present in tea is beset with a variety of difficulties.

Theine is known as trimethyl-xanthine, and also as methyl-theobromine. Its formula is $C_8H_{10}N_4O_2$ or (structurally) $C_5H(CH_3)_3N_4O_2$, It is odourless and bitter, and crystallises in long white flexible needles, which *felt* together in light fleecy masses. It is a very feeble base, and its salts are unstable. Caffeine was first obtained pure by Runge and others in 1821, and theine was also isolated by Oudry six years later; and it was Berzelius who first suggested that they were one and the same. Though now generally accepted as identical, the fact has not been absolutely established, for their physiological actions, as reported by Lauder Brunton and Cash, seem to differ, theine being apparently more powerful, and having a tendency to produce rhythmical contractions of the voluntary muscles, which would lead one to suppose that though isomeric, they are not identical. And there the matter rests at present, for though these differences in the physiological effects of the two drugs have been doubted, they have not yet been disproved. From experiments made on myself, I have found that coffee seems to have a decidedly antidotal effect to nicotine, a property tea does not appear to possess; but of course this does not go far towards establishing the separate identity of the two alkaloids.

I had purposed, as far back as a month ago, to make some investigations specially for this paper with regard to the characteristics of the three isomeric alkaloids, which are generally held to be one and the same—I mean caffeine, theine, and guaranine—but I much regret that I have been unable to obtain any but the second-named alkaloid (theine) from any manufacturer of drugs in London, neither could I manufacture the alkaloids for myself, as I was unable to obtain any Brazilian chocolate from which to extract its active principal (guaranine). Although I found the three alkaloids mentioned in several price lists, the vendors were unwilling to guarantee that all three were not got from tea, and this was all the more strange, when one noticed that the three were charged at very different prices (*e.g.*, theine, 2s. per oz., and guaranine at 8s. 9d. per drachm, or thirty-five times as expensive as theine). It is said that if both drugs are obtained absolutely pure, they are identical, and that the admixture of the essential oils of tea and coffee have led investigators astray.

The exact relations existing between xanthine, theobromine, theophylline, &c., can only be shown by fully developed structural formulæ, and the subject has been considered interesting enough to be now briefly referred to, so I give a Table, showing the synthesis of tea and the relations of various alkaloids (p. 218).

The obstinate retention for a prolonged time of a certain per-centage (from 15 to 30 per cent., according as to whether hot or cold water is used for its extraction) of the theine in the tea has suggested that part of the alkaloid exists in the plant in some almost insoluble combination in the cellular structure of the leaf.

On account of the refreshing properties due to theine, all the plants in various parts of the world that elaborate it are used for making beverages.

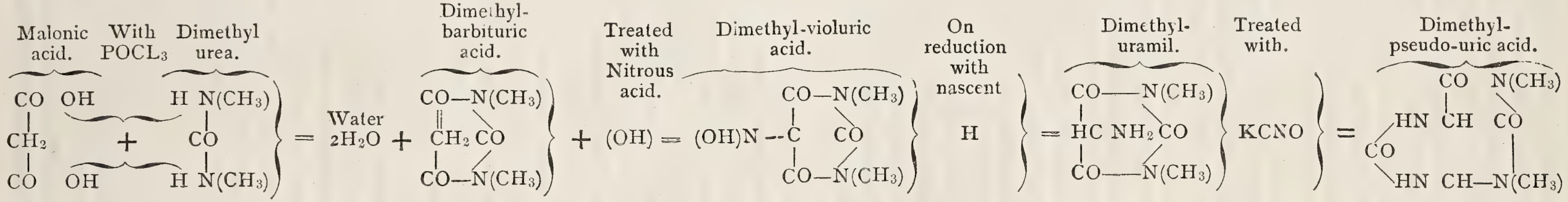
No doubt the value of a tea should be in direct proportion to the theine it contains, but Dr. Driver found, as a result of his analysis of twenty-eight samples, varying in price from 7d. to 7s., practically no more theine in high-priced teas than in common ones; for instance, in a sample of *strong* (in the technical acceptance) tea he found 4·43 per cent. of theine, and in a sample of *weak* tea, 4·35 per cent. The amount of chlorophyll present would seem to be actually a more reliable index of the quality of black tea since it varies from 3 per cent. in good to 1 per cent. in common teas.

What the consumer likes in tea is strength, body, and delicacy of flavour, but he cares little what amount of theine he gets, for he has no ready means of estimating the proportion present; yet, if he drinks tea on account of its refreshing properties, he would do well to see that he gets a maximum of the alkaloid which possesses this important characteristic.

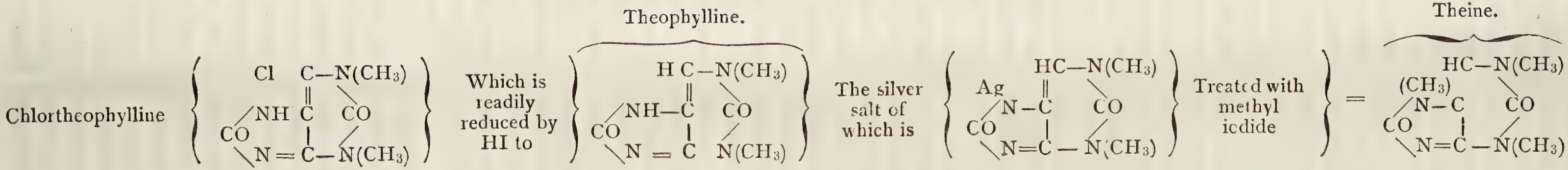
Plants which are able to elaborate certain alkaloids in one part of the world, either entirely fail to do so when transplanted to another part, or else only do so to a limited extent. The coca plant is a good instance in point. And it seems that for this reason Chinese tea contains less theine than Indian teas. Chinese contains the least, Japanese

SYNTHESIS OF CAFFEINE OR THEINE—(FROM FISCHER AND ASH).

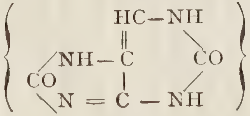
Illustrating the Relations of Various Alkaloids.



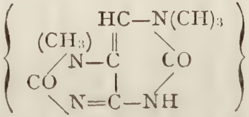
And this substance (dimethyl-pseudo-uric acid), by heating with a large excess of oxalic acid, is converted into dimethyl uric acid, which, if heated with the pentachloride (PCl_5) and oxychloride ($POCl_3$) of phosphorus, gives—


Chlortheophylline
Which is readily reduced by HI to
Theophylline.
The silver salt of which is
Treated with methyl iodide
Theine.

Therefore it will be seen that theine is evidently the trimethyl derivative of xanthine ....



Theine is the only trimethyl xanthine, but there are two isomeric dimethyl xanthines, one of which is theophylline (for formula see above) and the other, viz., theobromine, can be readily deduced to be



Paraxanthine is an isomer of xanthine, but its constitution is still undetermined.

The series stops at theine, because there are no more "imido" (—NH groups) hydrogens, and therefore no more methyl groups can be introduced.

The relation of assamin to the above group is undetermined, as its constitution has not yet been made out.

Alkalies easily decompose theine into dimethyl urea and oxalic acid. On boiling with lime, it is also partly decomposed, yielding ammonia and methylamine, and on warming with dilute caustic alkali, caffeidine-carboxylic acid ($C_8H_{12}N_4O_3$) is produced, which on further treatment yields caffeidine ($C_7H_{12}N_4O$).

slightly more, then Java, Ceylon, and Indian, in the order mentioned.

It is popularly supposed that tannin is present in tea in inverse ratio to the amount of theine, but this is not borne out by analysis.

Indian teas very often possess more of both tannin and theine than Chinese teas, but it must not be inferred from that fact that the consumer imbibes more tannin in the one case than in the other, for in household use more China tea has to be put into the pot than is the case with Indian tea. The action of tannin in the system has already been explained.

According to the older methods of analysis, the amount of theine present was often computed as low as 1 per cent., and even less. Then it was shown that the alkaloid was often present up to 4 per cent. Then close on 5 per cent. was discovered. Peligot next proved that it existed up to as much as 5·84 per cent., and about two years ago Mr. Christy stated that he had extracted over 6 per cent. of the alkaloid, and I myself have found just 6 per cent. in one sample; and I daresay that even more than that may yet be extracted from certain classes of tea by subsequent analyses.

During the processes of manufacture no theine is supposed to be lost, although it is comparatively easily sublimed. Albuminoid nitrogen is almost entirely absent during the later stages of growth, being found as theine; and connecting this with the facts that albumen has increased and that no theine exists in the seeds of tea, the alkaloid is pointed to as a decomposition product of albumen (like asparagine and glutamine) and capable of again forming albumen.

Theine can be obtained quite pure by sublimation, when it may be seen to consist of fine white monoclinic crystals possessing a silky sheen; they are fusible and have a bitter taste. The fine down (hair) which covers the unopened leaf-buds as well as the youngest leaves, also contains theine. To the presence of this hair the appearance of "golden-tip" and "silver-tip" tea is due. To a great extent, however, it is a waste product of manufacture, as it gets separated from the bulk of the tea during sieving and breaking; it floats about the sorting-room as an impalpable dust, and gradually accumulates on the walls and ceilings as a light-brown amorphous coating. It contains about 3 per cent. of theine, and I would suggest therefore that it be collected and the theine extracted therefrom, as also from the watery extract that drains from the leaf whilst fermenting, refuse tea, large prunings, &c.

There are several methods for the extraction of theine. The best one for commercial use is, I think, the following:—"Exhaust the tea with boiling water, boil the decoction with either litharge or acetate of lead, and concentrate the filtered solution till the alkaloid crystallises out on cooling. The product can be purified by resublimation, or by crystallisation from hot water." (Allen's Commercial Organic Analysis.)

Theine crystallises with from 7 to 8·5 per cent. of water. It does not evaporate with vapour of water, and undergoes no appreciable change of weight at 100°. At 120° it volatilises very gradually, and at a higher temperature sublimes unchanged in long silky needles. At 231° to 233° C., theine melts to a clear liquid, and at 384° (Strecker) boils and distils with partial decomposition, leaving no residuum.

Till quite lately theine could not be profitably manufactured in England owing to the prohibitive duty, which was not removed from damaged tea; but the Custom-house did at length admit "denatured" tea (*i.e.*, treated with lime and asafœtida) duty free; the consequence being that England has now become the chief seat of theine manufacture, and the price is about 2s. per ounce.

There are several other alkaloids found in tea besides theine, viz., theophyllin (Kossel), theobromine (Zöller and Liebig), assamin[*] (mentioned by Sohn), quercitrin, and quercetin (Hlasiwetz), as well as one or two undetermined ones. More should evidently be done to investigate these, so that their properties may be known.

This brings us to the end of the organic bodies, and we have now only one class left to treat of, viz.:—

THE INORGANIC BODIES.

These, of course, constitute the ash, in which the metals preponderate over the non-metals. The composition of tea ash is stated by Mr. Cripps, the well-known analyst, to be as follows:—

	Per cent.
Potash (K)	39·22
Soda (Na)	·65
Magnesia (Mg)	6·47
Lime (Ca)	4·24
Oxide of Iron (Fe_2O_3)	4·38

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[*] The constitution of assamin has not yet been definitely made out. For the close relation of the other alkaloids mentioned, see Table showing the synthesis of theine, p. 218.

	Per cent.
Protoxide of Manganese (MnO)	1·03
Phosphoric acid (H_3PO_4)	14·55
Chlorine (Cl)	·81
Sulphuric acid (H_2SO_4)	trace.
Silica (SiO_2)	4·35
Carbonic anhydride (CO_2)	24·30
	100·00

Out of these eleven constituents, it will be noticed that three of them, viz., K, H_3PO_4, and CO_2, account for nearly four-fifths of the total.

The elements mentioned in the Table are of course present in the plant in the form of various salts, and are taken up from the soil. The CO_2 is almost entirely formed by the destruction of the organic acids of the plant in presence of the bases above-mentioned.

THE CHEMISTRY OF THE PROCESS OF MANUFACTURE.

Whilst the leaf is withering, little chemical change takes place, beyond an incipient oxidation of some of the constituents of the sap. Withering is brought about by the evaporation of a certain variable amount of moisture, but generally about one-quarter of the original weight of the freshly-plucked leaf. This loss of moisture occasions a concentration of the sap; if this proceeds too far, however, (1) the cells will not burst in rolling; (2) some of the constituents of the sap will no longer remain in solution; and (3) the colour during fermentation will be uneven, owing to there being insufficient sap to spread over the whole surface of the rolled leaf.

If the fresh leaf is bruised, the air gains access to the sap during the withering process, and the tea is, in consequence, inferior both in quality of liquor and also in appearance, owing to decomposition and premature oxidation having set in.

If the leaf is exposed to a temperature which is excessive under the circumstances—as, for instance, exposure to the direct rays of the sun—an untimely oxidation will set in which will spoil the leaf for manufacture.

The object of rolling is to give a twist or roll to the leaf, and also to break the cells of the leaf and thus liberate the juices they contain, so that they may be further acted on during the next process, and also that they may be more capable of extraction with water.

On the cells being broken the sap escapes, and during the continuation of the rolling is spread all over the surface of the rolled leaf, where it is in a very favourable position for the oxygen to act on it during the next stage of manufacture, viz., fermentation. Some of this exuded sap is acted on by the hot air contained within the box of the rolling-machine, and, in consequence, a portion of the organic acids (chiefly the tannin) undergo partial oxidisation. Some of the tannin combines with the oxygen to form phlobaphene (Bamber), and also glucose and gallic acid, assuming a dark, insoluble form during the process; while part also combines with some of the albuminoid matter, an insoluble, leather-like substance resulting. These two last reactions are only incipient at this stage, but are more fully developed during the next process (fermentation).

The next process, viz., fermentation, is the most important one, from our present point of view, *i.e.*, the chemical aspect of the subject. Strictly speaking, it ought to be confined to a primary fermentation process (probably due to an oxidising enzyme); for if fermentation is further encouraged (by allowing the double-rolled leaf to lie about heaped up for any length of time, for instance) the tea manufactured from such leaf will be spoilt. In my opinion, this species of secondary fermentation and decomposition always begins to set in after the primary fermentation, or oxidation pure and simple, has prodeeded far towards completion, and it is to forestall the secondary fermentation more especially, as well as to fix the primary fermentation, that the first stage of firing is mainly intended.

Mr. Bamber asserts that there is no fermentation at all during the process which popularly bears that name in the industry, and he bases his theory on several experiments in which he failed to discover any micro-organisms; but recent research has shown that enzymes usually possess and oxidation action; and, again, if the process is only an oxidation one, why is it of such extreme importance to "fix" it by the first stage of firing at the exact moment when the climax is reached? For the firing would not fix oxidation, by any means, but would strongly tend towards hastening and increasing it. Therefore, I think that there is every reason to conclude that the technical term "fermentation" is quite correct.

My theory is that the process commonly known as fermentation in the tea industry is, during a greater part of the time, at any rate, mainly an oxidation one, but that later on (it takes a little time for the micro-organisms to develop and get to work), a fermentation due to an organism manifested (by the peculiar rancid odour produced by over-fermentation) of a butyric nature begins to be set up, which it is desirable in the extreme to arrest at the very outset, since its action is deleterious to the quality of the tea.

Fermentation may be described as the splitting up of complex organic substances into simpler bodies, by means of either (1) living organisms, or (2) natural ferments or enzymes.

Living germs (micro-organisms) are responsible for such fermentative processes as are carried on by the yeast plant, or in sour milk, rancid butter, or when nitrogenous matter acts on sugar to produce gum.

The natural ferments or enzymes are named diastase (in malt), emulsin (in almonds), invertin (in yeast), pepsin, ptyalin and trypsin (the active principles respectively of gastric, salivary, and pancreatic juices).

The primary fermentation that I have described as being the only one to be encouraged in tea, is due to one of the second class (*i.e.*, a non-living ferment), whereas the secondary fermentation, which is the one to be discouraged, and arrested by firing, can with a good deal of certainty be ascribed to a living germ or organised ferment.

For the oxidation process to be accomplished properly, the following points should be observed:—

(1). The leaf should be sufficiently withered and rolled, and then should be sieved to sort out the fine leaf from the coarse, as it is impossible to obtain an even fermentation if the two kinds are not dealt with separately.

(2). A clean, smooth cement floor on which the leaf should be evenly spread, not too thickly, and the leaf should be kept moist.

(3). A dark, cool, airy room, with a moist draught of air if possible.

(4). The temperature of the leaf should be kept below 85° F., if possible.

As regards the temperature at which tea should be kept during the oxidation stage, I have given what I consider is a minimum temperature obtainable under ordinary circumstances in a tea-house in the plains; but I hold that a maximum of coolness during the operation, so as to protract it as long as possible (without, of course, reaching the point when the secondary fermentation is in active force) ought to be the aim in view, for reasons that will have been noted when reading the remarks on the formation and decomposition of various substances during the processes of manufacture. In fact, it would be well worth while to ferment teas under such reduced temperature as can only be obtained in a tea factory by the artificial aid of a refrigerator. I made this suggestion in my MS. of "Tea" over a year ago, but I was misguided enough to circulate it. Since commencing to write this paper, I was apprised of the fact that a machine had been brought out somewhat on these lines; but as it did not altogether carry out my ideas, I determined, without delay, on bringing out a machine myself embodying all the points that I found, from a very extensive practical experience of and a large number of experiments with the fermentation of tea, were requisite.

One of the most important chemical changes at this stage, is an increased formation of essential oil, which it has been an aim in my machine to encourage.

The astringency of the tea is reduced by a further conversion of part of the tannin, to which this quality is mainly due, by a combination of part of the tanno-acids with some of the albuminoid matter, into a leathery substance which imparts the characteristic tough feeling to the leaf at this stage. These two last reactions usually commence during the rolling process.

A small quantity of the tannin is changed into gallic acid and glucose, and it would be a great advantage if more of it underwent this change, since gallic acid is not nearly so injurious to the human economy, when taken with albuminoid food, as tannin.

The pleasant aroma and nutty flavour of the leaf, so markedly developed during this process, are due to the formation of several volatile oils. If the process be too long continued, however, acids very similar to those present in rancid butter are formed, viz., butyric acid, &c. Prolonged firing will, of course, rid the tea of this disagreeable feature, but only at the expense of the greater part of essential oil as well. This acidity, due to butyric fermentation, causes the coagulation of some of the albuminoid matter, which is chiefly present in the form of vegetable casein (legumin), which is an alkaline albumen resembling the casein of milk. This coagulation is unfortunate, as it converts a valuable food material (which tea is very largely provided with) into an insoluble form, with the result that a large supply of nutriment is rendered useless. However, were it not already coagulated by the tannin, it would soon become so by the heat to which it would be subjected to in the firing.

During the first stage of firing an increased amount of essential oil is freed by the bursting of the cells, and perhaps a further quantity may also be formed by chemical action.

Another action of this operation is to arrest the secondary fermentation—by which I mean that fermentation which, as I have already explained, begins to set in when the oxidation has about reached its critical point. It also removes about 40 to 50 per cent. of the moisture from the half manufactured tea.

Special attention should be paid to avoid most of the important volatile constituents being carried away and lost owing to the employment of too high temperatures and draughts of too great a force.

The concluding operation that tea undergoes in the factories where it is manufactured is, of course, packing; and with regard to this, I may mention that it not unfrequently happens that when a wooden chest is opened, on its arrival in the docks, the tea is found to possess a very nasty, cheesy smell, which takes some time to completely pass off. For some time the only explanation for this rather disagreeable feature that was forthcoming was that the tea, under certain extraordinary circumstances, acted on the lead lining enveloping it. But, although experiments were tried to produce this state of things artificially, no such action could be got to occur; and then a new theory was started, placing the whole blame of the mischief on to using green wood for the boxes, the exudation from which had a corrosive action on the lead between the wood and the tea. However, this has not been actually established yet as the cause of "cheesiness." I have little doubt, in my own mind, that both reactions conjointly produce this objectionable occurrence, and that some emanation of the green wood corrodes the lead, and then either itself, or its compound with lead, acts on some constituent of the tea. Anyway, this is a point that naturally turns one's attention towards the several kinds of steel tea chests that are now being exploited.

DISCUSSION.

Mr. A. K. DONALD desired to elicit the views of Mr. Crole as to the infusion of tea. He wished to know whether, if tea had water poured over it quickly, and the tea was then taken away, one would get a considerable proportion of theine and very little tannic acid, or whether, if it was infused for a long time, the proportion of tannic acid would not be increased, as compared with the theine. Further, he would inquire what effect carbonate of soda had if put into the water; did not that extract more tannic acid. It certainly produced a very peculiar flavour; and it had been stated in some books (particularly in Professor Johnston's "Chemistry of Common Life") that putting in carbonate of soda had the effect of getting out some albuminoids, and consequently making the tea more nutritious. It would be interesting to know whether Mr. Crole had any theory upon this point.

Mr. H. E. BRISTOW, referring to the statement of Mr. Crole, that for the fermentation of tea a temperature of 85° or less should be maintained, remarked that no mention was made as to the length of time of fermentation. He would like to know whether there was any method of fixing the proper time for the fermentation process to last; was it to be determined in any other way than by the colour of the tea.

Mr. T. W. DAVIES said the reader of the paper had spoken of the principle of tea as an essential oil. He would like to know whether Mr. Crole had had a sufficient quantity of that essential oil to test it so as to know whether it was really an essential oil containing an hydrocarbon; might it not be a volatile alkaloid after the character of, for instance, nicotine.

Mr. D. M. STEWART asked if Mr. Crole's attention had been called to the differences of the teas of different districts. The remarks in the paper as to the cool temperature in which the fermentation should be carried out, led him (Mr. Stewart) to think of the difference there was between Darjeeling and almost all the Plains gardens in the matter of flavour. He had himself noticed, when in Darjeeling, that if a cool blast of air, such as was produced by a mist cloud coming down, went over a garden as the leaf was being plucked, as a rule the flavour was very much increased; that was what was known as the Darjeeling flavour. Mr. Crole did not seem to think that much change could take place while the leaf was growing, but this fact seemed to point in the other direction—that some change might take place whilst the leaf was growing, if there was a sudden change of temperature.

Mr. CROLE, in reply, said that when tea is infused the theine is extracted very much more rapidly than the tannin. For that reason, tea should only be infused for three or four minutes, in order to get the maximum of theine and the minimum of tannin; the tea-leaves should not be in the water more than four minutes. With regard to carbonate of soda, its action was, in the first place, to soften the water, thus allowing more of the flavouring matter to be extracted. Another prominent action was to diminish the astringency of the tea by neutralising, and even preventing the solution of the tannin. He did not think it had any other action on the constituents of tea.

He did not know what ruled the time of fermentation. In one garden it might be that eight hours' fermentation would be required, while the next, separated by only a fence, would not want more than two hours. The difference was probably due to soil and jât of tea. But he thought that teas should always be fermented according to their colour and smell, and not by any time method, unless, of course, they were fermented in a refrigerator. What the effect would be of a cold cloud, while the leaf was being plucked, he could not say; but undoubtedly a certain amount of cold during the process of fermentation was of great advantage. It was inexplicable to him that, while the tea was growing or being plucked, a cold cloud or cold blast should bring out the flavour, but he could understand that that might be the fact. Mr. Davies had spoken with regard to the essential oil in tea. There was little doubt that it was absolutely an essential oil; but there were other alkaloids, of course, in tea, and some of them had not been determined. He was himself working at the determination of one of them—not associated with the essential oil of tea, but with what was called boheic acid—and he thought he would be able to get an alkaloid from that. As he stated in the paper, boheic acid was probably not a single organic acid, but a compound of assamic acid either with another acid or with an alkaloid.

The CHAIRMAN, in moving a vote of thanks to Mr. Crole, said he was not capable of judging of the excellence of the paper from the technical and scientific point of view, but it contained some advice which he was quite sure was most useful and valuable, and which he hoped would be taken to heart. It was impossible to doubt, as was stated in the paper, that so long as the tea manufacture and similar manufactures were worked by mere rule of thumb, so long would the manufacturers fail to get the best that was to be got out of their products. The experiment was tried in Assam, for a short time, of having a chemist to help the planters generally in the process of manufacture. He had not heard what became of the experiment, but he believed it had not lasted for any length of time. It was one which of course could not succeed unless kept up for a number of years together; and it required an expert who should be well paid, and who would confine his whole time and labour to the study of chemical questions. He was sure that, both in the manufacture of tea and in the manufacture of indigo, such an experiment would pay the planting community over and over again. With regard to the remarks made in the last paragraph of the paper as to the cheesy smell of tea on arrival at the docks, that was an old question in Assam. He remembered that years ago there were endeavours to get rid of it by changes of boxes or by inquiries as to the chemical action on the lead, but nothing effectual had come of them. Concluding, the Chairman said he was sure he was only expressing the unanimous feeling of those who had heard the paper in offering Mr. Crole their very best thanks.

Mr. CHRISTISON said he thoroughly agreed with the Chairman as to the vast importance to the tea-planting industry of their having proper scientific assistance; and the sooner a competent expert was sent out the better. On the technical part of the paper he was not competent to speak, but thanks were due to Mr. Crole for devoting himself to scientific research on a subject that had been, probably, too little thought about.

The resolution was carried unanimously, and Mr. CROLE having briefly responded, the meeting terminated.

Correspondence.

MORAL ADVANCE OF THE PEOPLES OF INDIA.

With regard to the statements relating to the existence of slavery in India made in Mr. W. Lee-Warner's paper on the moral progress in that country during Her Majesty's reign, statements which appear to have been doubted by men from other parts than the Bombay Presidency, it will be found by reference to page 171, Vol. I., of my "History of the Land Revenue of Bombay," that such a state of affairs actually existed in the southern portion of the Surat collectorate up to the seventies. From personal recollection of what the state of matters then was, I should not be at all astonished to hear that slavery still exists there, probably in a modified form. The emancipation, attributed in the passage referred to, to the advent of the B. B. & C. I. Railway and the introduction of the Revenue Settlement, I can well recollect. The former operated by giving remunerative employment as labourers to the Dublas, who chiefly constituted the slave class, and led them to forsake their old masters without any fear of consequences. The mode in which the latter acted requires a little more explanation. The Bhátela Brahmans, frequently called the Desais, possessed such influence as heads of villages as to have been allowed, even under British rule, to appropriate to themselves under the names of Váda and Badlán (enclosures and exchange lands), the whole or nearly the whole of the village lands not actually under the plough for the time being, on the pretext that the soil generally was so poor as to require frequent fallows. The Dublas and other slaves, being thus unable to get land to cultivate, were at the mercy of the Brahmans. At the

Survey, all this extra land was assessed to the public revenue, and the Brahmans, when offered the option of paying for it or throwing it up, chose the latter alternative, thus giving a chance to the Dublas to acquire land, of which they eagerly availed themselves to become independent. I omitted to mention above that these slaves had a special name, and were called *Hâli*. The derivation of the word is doubtful, but it may come from *hal*, a plough. I cannot state exactly what rations the slaves received, but I know that they actually did receive food and clothing from their masters in the manner alleged by Mr. Lee-Warner.

A. ROGERS.

General J. MICHAEL, C.S.I. (member of the Indian Section) writes:—I was unable to be present at the meeting) before which Mr. Lee-Warner read his paper on the "Moral Advance of the Peoples of India during the Reign of Queen Victoria," but I have just read the paper in the *Journal*, and I am astonished at the assertion made by Mr. Krishna Menon, during the discussion, to the effect that slavery never existed in India. He asks "Where are the traces of the slavery so much spoken of ?" And after stating that he is a Malabar man himself—which his name shows—he says that he "knows the facts very well" and that "there was no slavery at all—he never heard of it." Fifty years ago, when I was engaged in organising the initial scheme of forest conservancy for the Madras Government, my avocations led me a great deal into the Malabar district, and I have, many a time, seen a Nair, or other caste man, stop short, while walking along a public road, and call out to a man or woman of the Poolyan or Charmar class (always then alluded to as slaves) approaching from the opposite direction, who would at once hurry off the road, to the prescribed distance, and the Nair would then, but not till then, continue on his way unpolluted. Poolyans or Charmars were fed, but not paid, by their masters. They cultivated his land and, until 1843, were his absolute property. Such slavery was formally abolished in that year, but its customs remained operative long afterwards. I have heard Civil officers, of that period, say that they used formerly to be obliged, in the course of their duty, to recognise documents affecting the transfer of property, in which houses, land, so many cattle, so many Charmars, &c., were set forth as items. This was, surely, slavery—and in a very abject form. Mr. Krishna Menon lives in happier times, and although he has never heard of this, it is nevertheless true. No one who knew Malabar in those days can doubt the fact that slavery existed throughout the district.

P.S.—Since writing the above I have had an opportunity of talking with Mr. Patrick Grant, late of the Madras Civil Service, who was Collector and Magistrate of Malabar for some years from 1858. I have his authority for saying that his experience, knowledge, and recollection tally with mine.

Obituary.

S. E. J. CLARKE.—Mr. Clarke, Secretary of the Bengal Chamber of Commerce, and an old and respected resident of Calcutta, died on Saturday, 23rd inst, after a short illness. He was a member of the Society of Arts, and on January 31, he read a paper before the Indian Section on "India and its Women."

General Notes.

MUNICH MOTOR EXHIBITION.—A second exhibition of motors and machine tools will be held at Munich in 1898. Applications will be received up to March 1, and programmes can be obtained from the offices of the exhibition, 1½ Färbengraben.

MOSCOW EXHIBITION OF BUILDING MATERIALS.—The Architectural Society of Moscow is arranging a permanent Exhibition of Building Materials and House-building Appurtenances, for the convenience of Russian builders and others connected with architecture. The Exhibition will be divided into three groups: Group 1, building materials, raw and made up; Group 2, objects pertaining to the sanitary question in building and other special work, and apparatus; Group 3, objects for the inside and outside finish of buildings, and furniture of apartments.

TURIN ELECTRICAL EXHIBITION, 1898. — An International Electrical Exhibition is to be held at Turin in 1898. The Executive Committee and the Special Commission invite exhibits from all parts of the world, and the Exhibition will embrace the following classes:—(1) Apparatus for teaching electrotechnics; (2) materials for conduction of electricity; (3) instruments for electric and magnetic measurements; (4) telegraphs and telephones; (5) signalling apparatus and safety appliances on railways, lighting and heating of carriages; (6) dynamos and motors; (7) mechanical appliances and electric traction; (8) electric lighting; (9) electro-chemistry and electrometallurgy; (10) miscellaneous; (11) apparatus of historic interest. Signor Gallileo Ferraris has been appointed President of the Commission.

MINES OF THE ARGENTINE REPUBLIC.—According to the report of the Argentine Director of Mines, the amount of gold taken from the mines during the last year was 473 kilogrammes, 10,210 kilogrammes of silver, and 389,900 kilogrammes of copper. The countries to which this output was exported were England, Germany, France, Belgium, and Italy. It is confidently believed by the director that the mineral output of the country was very much greater than the figures given in his report would appear to indicate. Constant efforts are being made to exploit mining properties in the Andes, and a renewed interest in mining is being manifested everywhere throughout the country.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday Evenings, at Eight o'clock:—

FEBRUARY 17.—"Light Railways." By EVERARD R. CALTHROP. The ATTORNEY-GENERAL, G.C.M.G., M.P., will preside.

FEBRUARY 24.—"Reproduction of Colour by Photographic Methods." By SIR HENRY TRUEMAN WOOD, M.A. CAPTAIN ABNEY, C.B., F.R.S., will preside.

MARCH 3.—"English Orchards."—By GEORGE GORDON. W. T. THISELTON DYER, C.M.G., F.R.S., Director of Kew Gardens, will preside.

MARCH 10.—"The Prevention of Fires due to the Leakage of Electricity." By FREDERICK BATHURST. W. H. PREECE, C.B., F.R.S., will preside.

MARCH 17.—"English Music in 1837: a Sixty Years' Retrospect." By J. SPENCER CURWEN. SIR WILLIAM CLEAVER FRANCIS ROBINSON, G.C.M.G., will preside.

MARCH 24.—"The Transmission of Power by Alternating Electric Currents." By W. B. ESSON, M.Inst.C.E.

MARCH 31.—"Cycling—Historical and Practical." By GEORGE LACY HILLIER.

APRIL 7.—"Dairy Produce and Milk Supply." By M. J. DUNSTAN, M.A., F.R.S.E.

Papers for evenings, the dates of which cannot yet be announced:—

"London Water Supply." By PERCY F. FRANKLAND, Ph.D., F.R.S.

"The Evolution of the Silver Question." By MORETON FREWEN, B.A.

"Children's Sight." By R. BRUDENELL CARTER, F.R.C.S.

"Fireproof Construction." By THOMAS POTTER.

"Motor Traffic: Technical Considerations." By Sir DAVID SALOMONS, Bart.

INDIAN SECTION.

MARCH 11, at 4.30 p.m.—"Prevention of Famine in India." By SIR CHARLES ALFRED ELLIOTT, K.C.S.I. (Secretary to the Famine Commission of 1878, and late Lieutenant-Governor of Bengal). The Rt. Hon. LORD GEORGE HAMILTON, M.P., Secretary of State for India, will preside.

MARCH 25, at 8 p.m.—"The Cultivation and Manufacture of Rhea Fibre." By THOMAS BARRACLOUGH. SIR WILLIAM HENRY HOULDSWORTH, Bart., M.P., will preside.

APRIL 8, at 4.30 p.m.—"A Visit to Russian Central Asia." By MICHAEL FRANCIS O'DWYER, I.C.S. (Assistant Commissioner in the Punjab).

APRIL 29, at 4.30 p.m.—"The Ethnology, Manners, and Customs of the People of Kafiristan." By SIR GEORGE SCOTT ROBERTSON, K.C.S.I. (late British Agent at Chitral).

MAY 20, at 4.30 p.m.—"India and its Commerce." By SIR JAMES LYLE MACKAY, K.C.I.E. (late President of the Bengal Chamber of Commerce).

The meetings of March 11, April 8, April 29, and May 20 will be held at the Society of Arts; and that of March 25 at the Imperial Institute.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

FEBRUARY 16.—"The Progress of Canada during the past Sixty Years of Her Majesty's Reign." By JOSEPH G. COLMER, C.M.G. The MARQUIS OF LORNE, K.T., will preside.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock:—

MARCH 2.—"Gesso." By MATTHEW WEBB.

MARCH 30.—"Lead-work." By W. R. LETHABY.

APRIL 27.—"Delft Ware." By Dr. J. W. L. GLAISHER, F.R.S.

MAY 11.—"A Half Century of Line Engraving, 1780-1830." By GEORGE CLULOW.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

C. F. CROSS, "The Industrial Uses of Cellulose." Three Lectures.

FEBRUARY 15.—LECTURE I.—General survey of industry in vegetable fibres—The small number available—Causes of limitations—Lessons of past failures—Forecast of future developments—The cellulose industries: (*a*) Paper-making; (*b*) Textiles (*c*) Miscellaneous, based upon special chemistry of cellulose derivatives—(*a*) Papers in relation to uses—Normal standards—Basis of classification, chemical composition, and mechanical properties.

FEBRUARY 22.—LECTURE II.—Paper-making (continued)—Recent progress in methods—The theory and practice of paper-sizing—Sizing with soluble cellulose compounds—(*b*) Textiles—Progress in chemical methods, in spinning (flax), and in yarn and cloth bleaching (cotton, linen, jute)—Mather-Kier system—Present position of rhea industry—Novel applications of mercerising process—Production of crépons by printing: alkali and acid processes—Finishing processes and new applications of cellulose compounds.

MARCH 1.—LECTURE III.—The chemical industries in cellulose compounds—Viscose and viscoid: production and applications—The spinning of "nitro-cellulose" and production of lustra cellulose (artificial silk)—Smokeless powders from structureless celluloses—Cellulose acetates: production and application.

Prof. W. Chandler Roberts-Austen, C.B., F.R.S., "Alloys." Four Lectures.
March 15, 22, 29, April 5.

Lewis Foreman Day, "Design in Lettering." Four Lectures.
May 3, 10, 17, 24.

Howard Lectures.

Thursday Evenings, at Eight o'clock:—

Prof. James A. Ewing, M.A., F.R.S., "The Mechanical Production of Cold." Six Lectures.

February 18. — Lecture IV. — Modern machines: their construction and practical working—Ammonia machines: Linde, &c.—Sulphurous acid machines: Pictet—Carbonic acid machines; Windhausen, Hall—Compressors, condensers, refrigerators.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 15 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. C. F. Cross, "The Industrial Uses of Cellulose." (Lecture I.)

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. A. Wynter Blyth, "Factory Legislation."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Adjourned discussion on Mr. W. J. Dibdin's paper, "The Character of the London Water Supply."

Imperial Institute, South Kensington, S.W., 8½ p.m. Professor W. E. Ayrton, "Sixty Years of Submarine Telegraphy."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. H. E. Milner, "The Garden in Relation to the House."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Paper on "Inherited and Hereditary Characters."

London Institution, Finsbury-circus, E.C., 5 p.m. Professor F. Hickson, "The Fauna of the High Seas."

Tuesday, Feb. 16 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. Joseph Colmer, "The Progress of Canada during the past Sixty Years of Her Majesty's Reign."

Royal Institution, Albemarle-street, W., 3 p.m., Professor A. D. Walker, "Animal Electricity." (Lecture IV.)

Self-Propelled Traffic Association, Colquitt-street, Liverpool, 8 p.m. Mr. Rhys Jenkins, "Compressed Air and Motive Force for Road Vehicles."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Adjourned Discussion on Mr. H. F. Donaldson's Paper, "Cold Storage at the London and India Docks."

Statistical, in the Theatre of the United Service Institution, Whitehall, S.W., 5½ p.m. Mr. Noel A. Humphreys, "English Vaccination and Small-pox Statistics, with Special Reference to the Report of the Royal Commission, and to recent Small-pox Epidemics."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 12, Hanover-square, W., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. A. Smith Woodward, "*Echidnocephalus*: a Halosauroid Fish from the Upper Cretaceous Formation of Westphalia." 2. Mr. G. A. Boulenger, "A Specimen of *Acanthocybium solandii* from the Arabian Sea." 3. Mr. W. E. de Winton, "Remarks on the Existing Forms of Giraffe."

Geological, Burlington-house, W., 3 p.m. Annual Meeting.

Wednesday, Feb. 17...SOCIETY OF ARTS, John-street, Adelphi, S.W., 8 p.m. Mr. Everard R. Calthrop, "Light Railways."

Meteorological, 25, Great George-street, S.W., 7½ p.m. 1. Mr. Edward Mawley, "Report on the Phenological Observations for 1896." 2. Hon. F. A. Rollo Russell, "Results of Observations on Haze and Transparency near Haslemere, Surrey."

Microscopical, 20, Hanover-square, W., 8 p.m. Mr. G. M. Giles, "A Simple Method of Micro-Photography."

Institute of Mining and Metallurgy, Geological Museum, Jermyn-street, S.W., 8 p.m. 1. Mr. T. H. Leggett, "Additional Notes on the Treatment of Zinc-box precipitate ('Slimes') from the Cyanide Process." 2. Mr. P. R. Roberts, "Notes on Milling at the North Star Mine, Grass Valley, California." 3. Mr. T. Trafford Wynne, "The Ruby Mines of Burma."

Archæological Association, 32, Sackville-street, W., 8 p.m.

United Service Institute, Whitehall, S.W., 3 p.m. Capt. Hilliard-Atteridge, "The Dongola Expedition of 1896."

Thursday, Feb. 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Howard Lectures.) Professor James A. Ewing, "The Mechanical Production of Cold." (Lecture IV.)

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. D. T. Gwynne Vaughan, "On certain points in the Anatomy and Morphology of the Nymphæaceæ." 2. Mr. T. H. Burrage, "The Adhesive Discs of *Ercilla spicate*, (Roq.)

Chemical, Burlington-house, W., 8 p.m. 1. Messrs. T. S. Dymond and F. Hughes, "The Oxidation of Sulphurous Acid by Potassium Permanganate." 2. Professor A. W. Titherly, (i) "Sodamine and some of its Substitution Derivatives;" (ii) 'Rubidamide."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. J. Scott Keltie, "The Arctic Record."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. Herbert Manly, "Sanitary Law and Public Health Acts."

Royal Institution, Albemarle-street, W., 3 p.m., Dr. J. W. Gregory, "The Problems of Arctic Geology." (Lecture II.)

Historical, 28, Jermyn-street, S.W., 8½ p.m. Annual Meeting.

Numismatic, 22, Albemarle-street, W., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Sydney Rowland, "Practical Use of X Rays."

Friday, Feb. 19...Royal Institution, Albemarle-street, W., Dr. Johnstone Stoney, "The Approaching Return of the Great Swarm of November Meteorites."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Saturday, Feb. 20... Royal Institution, Albemarle-street, 3 p.m. Mr. W. F. Lord, "The Growth of the Mediterranean Route to the East." (Lecture II.)

Journal of the Society of Arts.

No. 2,309. Vol. XLV.

FRIDAY, FEBRUARY 19, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ALBERT MEDAL.

The Council of the Society attended at Marlborough-house on Tuesday, 16th instant, when His Royal Highness the Prince of Wales, K.G., President of the Society, presented the Albert Medal to Prof. David Edward Hughes, F.R.S., "in recognition of the services he has rendered to Arts, Manufactures, and Commerce, by his numerous inventions in electricity and magnetism, especially the printing telegraph and the microphone."

The members of the Council present were—Major-Gen. Sir Owen Tudor Burne, G.C.I.E., K.C.S.I. (Chairman), J. Wolfe Barry, C.B., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., Viscount Cross, G.C.B., Joseph G. Gordon, Sir Charles M. Kennedy, K.C.M.G., Sir Stuart Knill, Bart., William Henry Preece, C.B., F.R.S., Sir Owen Roberts, D.C.L., Professor Roberts-Austen, C.B., F.R.S., Sir Saul Samuel, K.C.M.G., C.B., Alexander Siemens, with Sir Henry Trueman Wood, Secretary, and Henry B. Wheatley, Assistant-Secretary.

REPRODUCTION OF COLOUR BY PHOTOGRAPHIC METHODS.

As a number of members have expressed a wish to hear the paper on the "Reproduction of Colour by Photographic Methods," which will be read by the Secretary on the 24th inst., it has been decided to ask the members to forego the privilege of introducing friends by ticket on that evening. It is thought that this arrangement will be for the general convenience of members, and will allow a greater number of them to be present. They will still be entitled to introduce personally a single friend.

The Specimens used to illustrate the paper will remain on view at the Society's Rooms on Thursday 25th from 11 to 9, Friday 26th from 11 to 5, and on Saturday 27th from 11 to 2, when they can be inspected by anyone introduced by a member.

CANTOR LECTURES.

The first lecture of the course on "The Industrial Uses of Cellulose" was delivered by Mr. C. F. Cross on Monday evening, 15th inst.

The lectures will be printed in the *Journal* during the summer recess.

HOWARD LECTURES.

Professor James A. Ewing, M.A., F.R.S., delivered the third lecture of his course on "The Mechanical Production of Cold" on Thursday evening, 11th inst.

The lectures will be printed in the *Journal* during the summer recess.

FOREIGN & COLONIAL SECTION.

Tuesday, February 16, 1897; The Marquis of Lorne, K.T., in the chair.

The paper read was:—"The Progress of Canada during the Sixty Years of her Majesty's Reign," by Joseph G. Colmer, C.M.G.

The paper and report of the discussion will be published in a future number of the *Journal*.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, Jan. 26, 1897; Lewis Foreman Day in the chair.

The paper read was—

THE ARTISTIC TREATMENT OF HERALDRY.

By W. H. St. John Hope, M.A.

In laying before you this evening a few suggestions on the artistic treatment of Heraldry, I assume that most of those present have some idea what Heraldry is, and are sufficiently acquainted with the rudiments of the science to justify my passing over such matters as may be readily learnt from text-books like Boutell's smaller work on "English Heraldry."

The subject of the artistic treatment of heraldry is not one that can be dealt with satisfactorily in a short paper, even with the aid of illustrations. It is rather one to be studied from good examples of the many applications of it in which our forefathers took such delight, as on tombs and in painted glass, or in conjunction with architecture or coloured decoration generally. The best examples of all are to be found on seals (*e.g.* Figs. 1, 2, 3), but these, unfortunately, are not so available for study as the more accessible authorities I have just named.

Fig. 1.

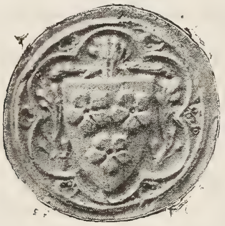


Fig. 2.

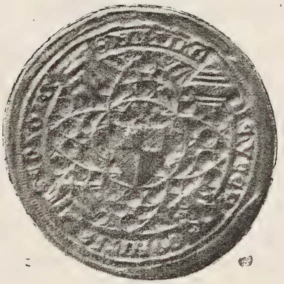
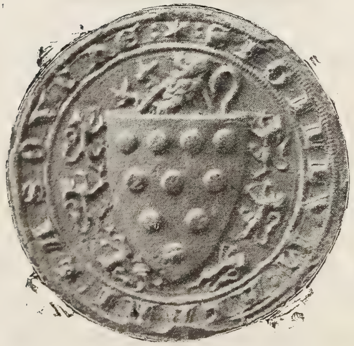


Fig. 3.



Examples of Heraldic Seals.

Fig. 1.—Hugh Bardolf. Fig. 2.—Maud, Countess of Oxford, 1336. Fig. 3.—Alan la Zouche. (Figs. 1 and 3 are appended to the Barons' Letter of 12 Feb. 1300 1.)

Heraldry, as we know it, was first reduced to a science in this country about the beginning of the 13th century, and we fortunately possess a long and splendid series of examples of its use, even from the first, from which much valuable instruction may be derived.

The question has perhaps often suggested itself to some of you, why do the ancient applications of heraldry always look well, while the modern attempts to use it are invariably dull, lifeless, and uninteresting? The answer is much the same as the explanation of the difference in appearance between the old west front of the cathedral church of Peterborough and the new north front of Westminster Abbey. The one was the handiwork of masons who were themselves artists, while the other is the mechanical interpretation of an architect's drawings by mere human machines who worked by rule. Ancient heraldic art was the product of men who thoroughly understood it and revelled in it. Modern heraldry is a lifeless thing dependent on needless rules and restrictions, and derived from a succession of text-books and manuals that might profitably be collected and burnt in one huge bonfire.

I propose on the present occasion to deal with English heraldry only. Not that no other is worthy of consideration, but because there is not time except for the one, and that so fully illustrates the general principles of artistic heraldry followed in other countries that it is unnecessary to go further afield.

We will begin with a consideration of shields and their treatment.

The shape of a shield is in itself entirely arbitrary and devoid of meaning, and varied from time to time simply from change of fashion, like the form of an arch or the design of a window. These changes must not however be overlooked, for the shape of a shield varies according to its date, and it would be absurd to use one of the ornate forms of the fifteenth or sixteenth century on which to paint, say, a lion of a thirteenth century type, or to fill an early form of shield with charges that tell of a much later date. There will, however, be found from the 13th century downwards one simple form of shield, that known as the heater shape, from its likeness to the base of a flat iron, which, on account of its capability of displaying any one of the countless possible combinations of heraldic charges, has continued always in use. This form may safely be adopted in general practice, and the elastic way in which its curves can be slightly altered when required specially commends it.

For the arms of ladies lozenge-shaped shields (Fig. 4) began to be used early in the 14th century (see Fig. 2), but this most inconvenient form did not come into common use until very much later.

From the form of the shield we may pass to the consideration of its surface or field, and the way in which this should be treated.

In the simpler shapes the field when painted is invariably shewn flat, but if carved a slight convexity, or even concavity, is often met with,

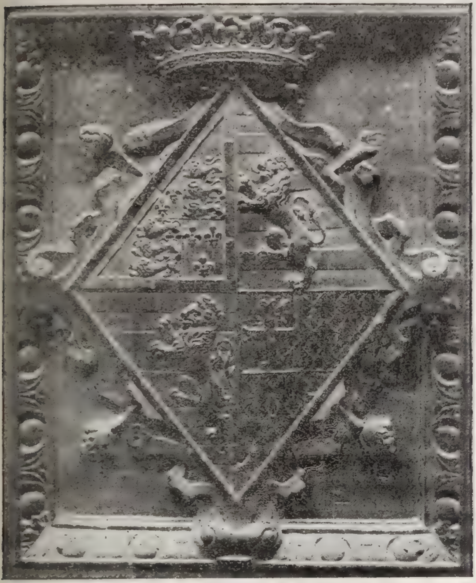


FIG. 4.—Lozenge with the Arms of Frances Brandon, Duchess of Suffolk (ob. 1559), from her tomb in Westminster Abbey Church.

the artistic advantages of which I need not dwell upon. Some of the ornate late forms, such as shields with incurved or engrailed edges, are often worked when carved into a series of ridges and furrows (as in Fig. 5*), and occasionally with good effect, but there is a tendency to carry this to excess, and so to injure the appearance of the charges. If the shield is well covered by the bearings on it, it is better to use a simple form than one with a ridged surface.

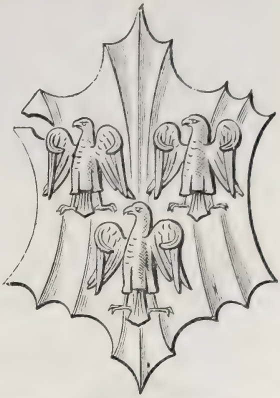


FIG. 5.—Shield of ornate form from the chantry chapel of Thomas Ramryge, Abbot of St. Albans, *circa* 1500.

A reference to a number of good ancient examples of heraldic shields will disclose the care that has been taken to cover or fill up the field, as far as possible, with whatever is placed upon it. A lion or an eagle, for instance, will have the limbs and extremities spread out so as to fill every available corner (see Fig 6);

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* Figs. 5, 20, 21, 23, and 24 are lent by Messrs. Cassell.

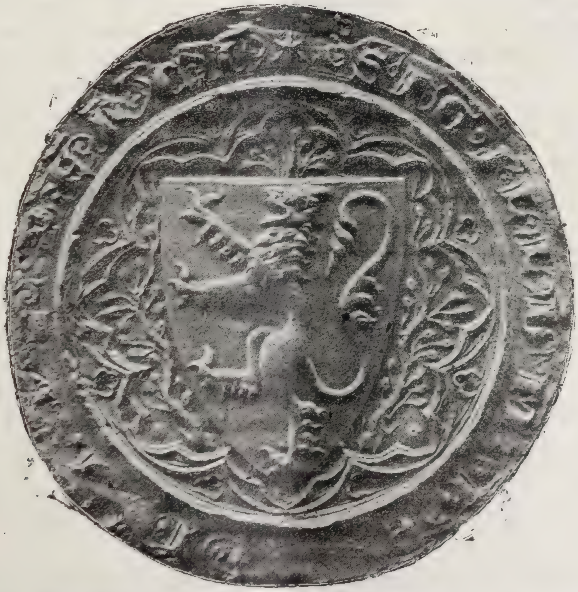

FIG. 6.—Seal of Henry de Percy, showing heraldic treatment of a lion rampant. (From the Barons' Letter of 12 Feb. 1300-1.)

and the same will be found in every group or combination containing objects capable of arrangement or extension. (Fig. 7.) Even with most unpromising combinations, or a group of charges that cannot be extended or altered in any way, or with a single ordinary like a bend, pale, or chevron, the mediæval artist was still equal to the occasion, and by judicious adjustment of proportions, or some equally common-sense method, contrived to make his shield look well. Another important point will also be noticed in all ancient heraldry, that in shields containing a number of like objects, such as the three lions of the royal arms, no two are exactly alike, but each differs slightly from another in pose or in size, according to its place in the shield. (See Fig. 8.) So, too, lines and curves are hardly ever quite true, but are drawn by hand, and not with pen or compasses.

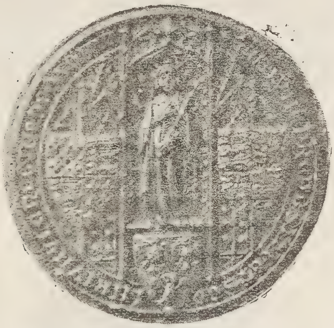

Fig. 7.—Seal of Queens' College, Oxford, 1340, showing treatment of shields.

Herein lies one of the great differences between the ancient and the modern treatment of heraldry. The modern artist draws his lines and curves with mechanical precision; his charges are exact copies one of another; the fact that they do not fill up the field is quite unimportant; and the final result is in every way unsatisfactory and hopelessly bad. Until such first principles as those I have shown to be what the old men followed be adopted and practised, no good result can be looked for.

Another feature of the old heraldry which it is well to bear in mind is the sparing use of that method of combining the arms of two or more persons or families in the same shield, which is known as "quartering." One of the oldest examples of this occurs on the tomb of Queen Eleanor, the consort of Edward I., in Westminster Abbey, where her paternal arms of Castile and Leon are so arranged. So long as the shield contained four quarters only, of which the first and fourth and the second and third were respectively alike, the effect was often good, as in the case just noticed, and in the beautiful royal arms of Edward III. (Fig. 8.*) But where, as became common in the 15th century, these quarters were multiplied or sub-divided, the artistic effect of the old simple shields was destroyed. As the principle was further abused, especially in the Elizabethan and Stuart periods, the whole became more and more confused in appearance, until the field rather resembled a piece of Turkey carpet than a combination of various arms, each more or less beautiful in itself.

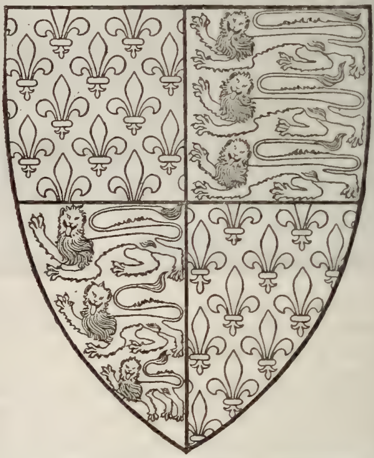

Fig. 8.—Royal Arms of King Edward III. (ob. 1377). From his tomb at Westminster.

Another cause of the bad effect of much modern heraldry is to be found in the rules laid down in some of the text-books and manuals as to the relative widths of the ordinaries and subordinaries. The old heralds certainly did not fetter themselves with such restrictions. A bend or a chevron or a cross, whether alone or charged, was drawn of the best proportion to look well. If placed between other charges it was drawn narrower, if itself uncharged, and thus took its proper relative position with respect to the size and arrangement of the charges. So too, with a bordure: if uncharged, or merely company, it was drawn very narrow; and even if charged, or engrailed, it was not allowed a much greater width. (Fig. 9.) It thus never unduly intruded itself upon the other charges of the shield, and yet continued an artistic addition in itself.

In many ancient heraldic shields, especially in painted glass, and to a lesser extent in carved work, the uncharged surfaces of the field or ordinary, are sometimes relieved by covering them with the purely ornamental decoration known as "diapering." (Fig. 10.) This beautiful treatment has, happily, been largely revived of late years by the glass painters, who use it very successfully, probably from the ease with which in their case it can be applied. Carvers, like their mediæval predecessors, use it very sparingly; this is perhaps as it should be. Diapering requires to be done with great skill in sculpture to look well, and a careful study of old examples is advisable, in order to thoroughly understand the principles of its application. Some of the finest diapered shields we have occur on the splendid monument of Lady Eleanor Percy in Beverley Minster. A few good instances are also to be met with on seals. (Figs. 11 and 16.) It is, of course, to be borne in mind that diapering is merely a relieving of the surface, and it must not be emphasized by a difference of colour, or treated with such prominence as to render it liable to be mistaken for a charge or charges.

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* Figs. 8, 12, and 30 are lent by Messrs. Longmans.

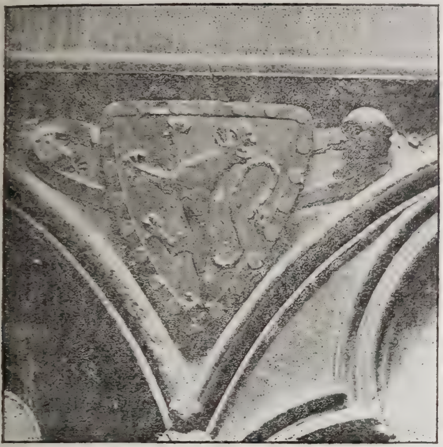

Fig. 9.—Shield of Richard, Earl of Cornwall and King of the Romans (ob. 1272). From the nave of Westminster Abbey Church (c. 1260). Shewing narrow bordure.

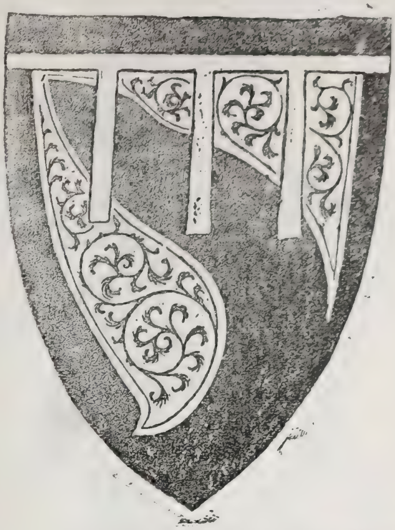

Fig. 10.—Diapered Shield with the Arms of Sir Hugh Hastings (ob. 1347). From his brass in Elsing Church, Norfolk.

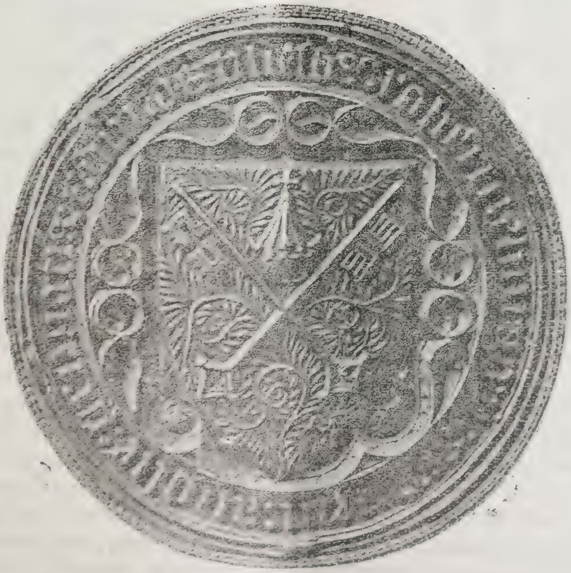

Fig. 11.—Seal of Archbishop Waldeby for the Regality of Hexham 1397, with diapered Shield of the Arms of the See of York.

On the question of what tint or colours ought to be preferred in heraldic decoration, I do not think I need take up your time, as some excellent suggestions will be found in Mr. Boutell's manual before referred to.

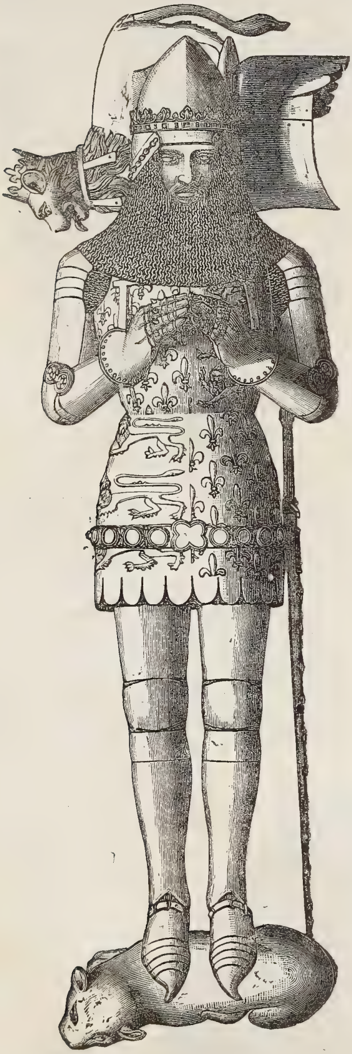

FIG. 12.—Latten effigy of Edward the Black Prince (ob. 1376) at Canterbury. Showing early treatment of crest and mantling; the Prince also wears a coat of arms.

I should, however, before passing on to other matters, like to enter an earnest protest against what I may call the "dot-and-dash" system of expressing gold and the several colours. This disfiguring method of showing the tinctures was not invented until the end of the 16th century, and it is absolutely destructive of the artistic effect of any shield. Yet carvers and sculptors delight in its use, and examples abound in our streets and on our public buildings. If these good craftsmen would satisfy their craving for relieving plain surfaces by filling up the shield as far as possible with its charges, or by the skilful and judicious use of diaper work, the poor shields would look better and the artist's capabilities be enlarged.

Finally, before leaving the shield, let me say a word as to the treatment of the label. This, as some of you may know, is a narrow band, with three or five long pendent strips or "points," placed upon and across the upper part of a shield. It is now used to distinguish the arms of an eldest son from those of his father. Anciently the label was very narrow, sometimes even a mere line or cord, and the pendent points were narrow strips of the same or nearly the same width throughout, even when charged as they occasionally were. In modern heraldry the label is often drawn unduly wide and the points have become short and ugly wedge-shaped pieces hanging from it. The result is that instead of being an unobtrusive addition to the shield, the label becomes the most conspicuous part of it and destructive of all artistic effect.

I must now say a few words concerning crests, the meaning and use of which seem to have been almost entirely forgotten. A crest was originally, as its name reminds us, a tuft or plume on the head of a bird. Such a tuft or plume in very early times was fixed as an ornament in the top of a helmet, of which it thus formed the crest. Other devices, such as could be conveniently so worn, were soon used for the same purpose, and by a perfectly natural process became associated with particular individuals. In later days when the helmet enveloped the whole head the crest played a useful part in revealing the wearer's identity, though his face was hidden. As the crest was thus so closely associated with the helm it was never represented separated from it, except in some few cases where it stood upon a cap of maintenance, and in some late examples of standards. So, too, the crest was always something that could be actually worn, objects that were naturally too large or heavy being represented by models made in boiled leather (*cuir-bouilli*), wood, or other light material. Such impossible crests as the pictorial scenes and other absurdities granted by the heralds in this and the last century, and even back into Elizabethan times, would not have been thought of at an earlier period while heraldry was a living art.

The helm of which the crest formed part was, it is hardly necessary to say, such a one as was included in the war harness of the time. In heraldry it was almost invariably shown in profile, the present custom of using different types facing different ways to denote various grades of rank, being a comparatively recent one. In actual use the helm was often covered behind by a scarf of some kind, to temper the heat of the sun, like a modern puggaree. Heraldically this is represented by what is called the mantling. At first this was a simple affair, disposed puggaree fashion, as on the effigy of Edward, Prince of Wales, at Canterbury (Fig. 12), but it was by degrees enlarged until it extended on either side beyond the helm, and was disposed in graceful twists and folds with dagged edges which are supposed to represent the cuts it was liable to receive in war. The usual colour for the mantling was red, and it was lined with ermine fur, but there is ample precedent for a difference of treatment, as may be seen in that wonderful storehouse of ancient heraldry, the stall-plates of the Knights of the Garter in St. George's Chapel, Windsor, where mantlings of various colours, and powdered with badges, or formed of feathers, occur (Figs. 13, 14, 15).

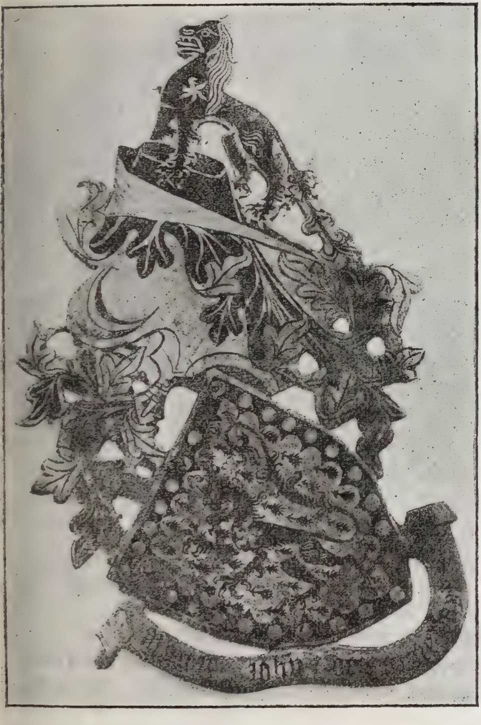

FIG. 13.—Stall-plate of John, Lord Cornwall, K.G. c. 1409-1443. Date of plate, 1422.

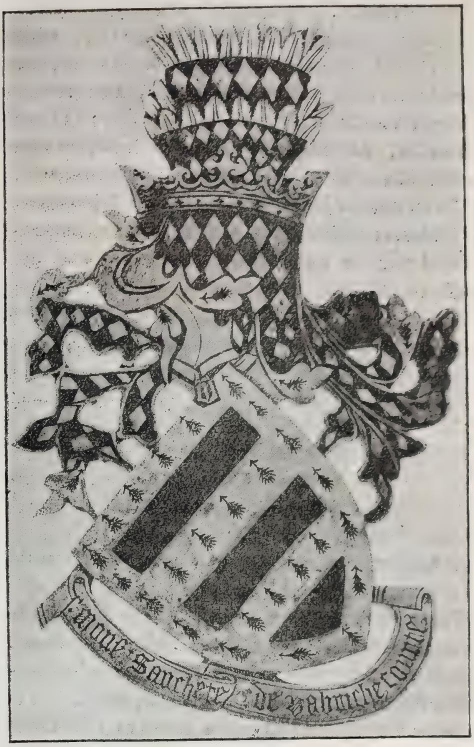

FIG 14.—Stall-plate of Sir Sanchet d'Abrichecourt, K.G. 1348-c. 1360. Date of plate, 1422.

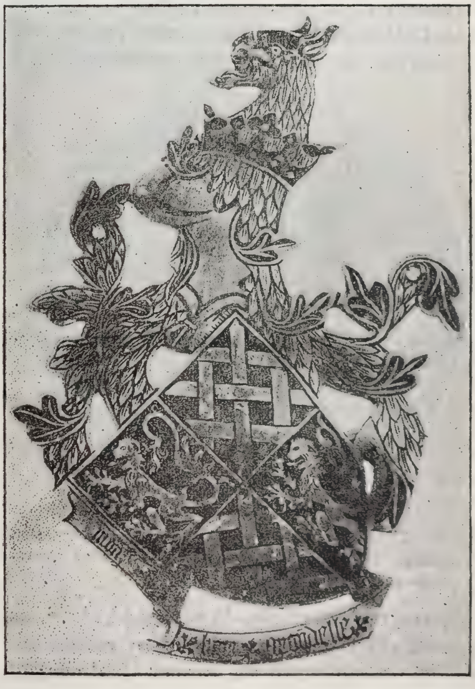

FIG. 15.—Stall-plate of Sir William Arundel, K.G. 1395-1400. Date of plate, 1422.

Of wreaths, coronets, and the caps of maintenance usually associated with helms and crests, I need not say much. The history of their origin and use really belongs to the grammar of heraldry. Good examples, as models, should however be looked for, and of these there is, fortunately, no lack, as, for instance, on the stall-plates at Windsor, or the beautiful plates of monumental effigies published by Stothard and the brothers Hollis.

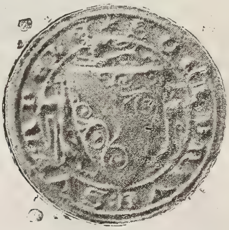

Fig. 16.—Privy Seal of Peter de Mauley III. (From the Barons' Letter of 12 Feb. 1300-1.

From what I have said as to the invariable ancient close association of helm and crest, it follows that the modern fashion of representing the crest by itself, without the helm, is entirely wrong. It at once renders the crest meaningless; in appearance it forthwith becomes insignificant, and any attempt to treat it artistically is usually a failure. Let crests be shown as crests, with practicable helms beneath them, and with the mantling treated with all the freedom that it is capable of.

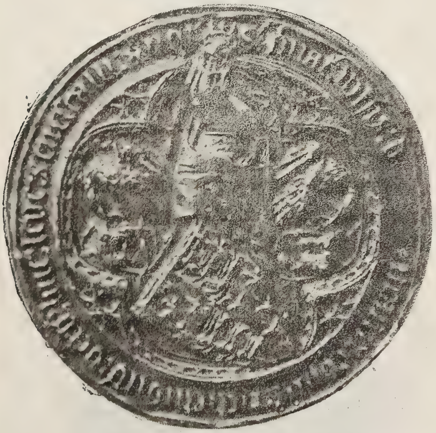

Fig. 17.—Privy Seal of John of Ghent, Duke of Lancaster, c. 1362. With falcon-and-fetterlock badge on each side of the shield.

Crests, unfortunately, do not stand alone, as regards their misuse, for modern artists are equally at sea as to the proper treatment of supporters. These charming adjuncts to heraldic compositions no doubt originated in the animals or badges often introduced on early circular seals, to fill up the space between the shield and the surrounding margin (Figs. 16, 17, 21, 29).

A very slight exercise of the engraver's inventive powers represented these beasts as holding the shield itself, and thus they became the supporters of it. Once invented, they were very popular, and many grand examples occur on seals and monuments. (Figs. 18, 19). In those mediæval instances where the shield is surmounted by, and more or less subordinate to, the helm, crest, and mantling, the supporters invariably uphold the helm, as being the heavier and uppermost object, the shield being assumed to depend from it. But whatever the thing supported, whether a shield alone, or the helm and crest and shield combined, it ought not to be forgotten that the duty of supporters is to uphold and support. Now-a-days, however, especially in representations of the royal arms, the so-called "supporters" often do not support anything, but are degraded into a pair of cowering beasts at the base of the shield, like the lion and unicorn over the door of the new National Portrait Gallery. The depth of heraldic degradation could hardly be illustrated better than by this very recent representation of the royal arms. In marked contrast to them are the boldly sculptured arms of George I. (1726) over the portico of St. Martin's Church hard by.

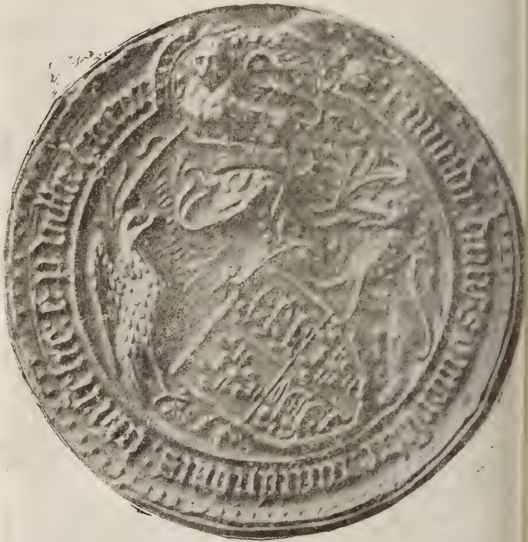

Fig. 18.—Seal of Edmund, Duke of Somerset, as Governor of Caen, 1449-50, showing treatment of supporters.

During the 15th and 16th centuries a pretty fashion prevailed of utilising heraldic creatures generally as supporters or bearers of banners, which were often charged with arms or devices. Some of you may be familiar with the grand examples at the corners of the tomb in Westminster Abbey of Lewis Robsart, Lord Bourchier, who died in 1431. In this case large quartered banners of arms, the poles of which are ingeniously worked into the buttresses, are held by lions and falcons alternately. Some beautiful examples also occur on seals.

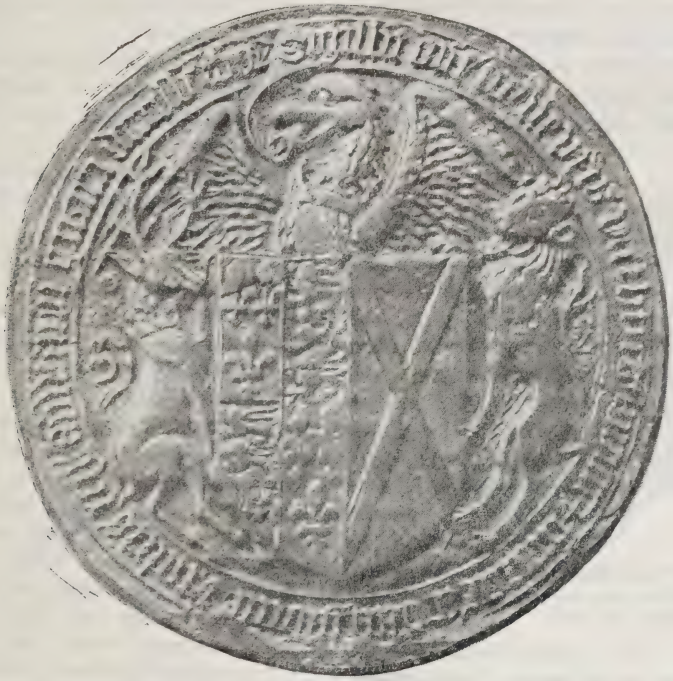

Fig. 19.—Seal of Cecily, Duchess of York. mother of Edward IV., c. 1461. The scroll is held by a silver falcon, a badge of the House of York; the shield is supported by a stag and the white lion of the House of March.

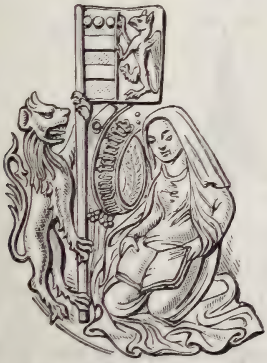

Fig. 20.—Part of the Seal of Margaret, Lady Hungerford, (ob. 1477) with a lion bearing a banner with the impaled arms of Hungerford and Bottreaux.

(Fig. 20). In architecture these banner-bearing creatures were often used with happy effect as terminals to buttresses or pinnacles and in other suitable places. The buttresses of St. George's Chapel, Windsor, for instance, were once surmounted by stone figures of the "King's beasts," as they were called, holding long rods with gilt vanes, the effect of which as they turned with the wind in the sun must have been very pretty. Similar figures also formerly stood on stone bases at the angles of the trim little walks in the privy garden at Hampton Court.

The use of banners for the display of armorial bearings might with advantage be more widely adopted. Everyone is familiar with the banner of the royal arms, which is so wrongly called the royal standard, and with our splendid national naval banner, better known as the Union Jack. Many of you too, may have noticed the banner with the arms of the city of London, which floats above the Mansion House when the Lord Mayor is in residence. Let a banner once be regarded in the light of a rectangular shield, and its fitness for armorial bearings directly becomes apparent. Mediæval banners of arms were usually placed upright, that is with the long side next the staff, and in this form they have an excellent decorative effect. (Fig. 21). At a later date they became square, (Fig.

20) and then longer than they were high, so reversing the old state of things. In practice it will be found that though this latest form is convenient when the banner is used as a flag, it is not always easy so so to arrange the arms on it that they will look well. In the royal banner for example, although the lions of England may be sufficiently elongated and attenuated to fill up the quarters allotted to them, it is very difficult to properly display the lion rampant of Scotland in a space which is more suitable for a lion passant. Had the banner been of the old form, or even square, no difficulties whatever would have arisen.

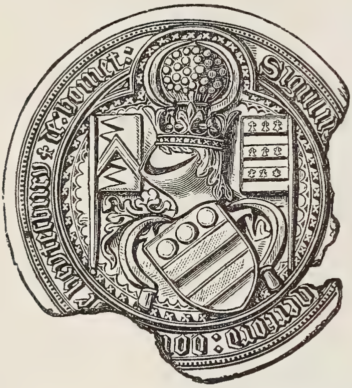

FIG. 21.—Seal of Sir Walter Hungerford, K.G., 1425, with sickles (his badge) as supporters, and banners of his baronies of Heytesbury and Hussy.

Whatever be their shape, banners, like shields, ought as a rule to be completely covered with the heraldry, like the modern banners of the Knights of the Garter at Windsor. Examples, however, are not wanting even in the 15th century, of banners charged with regular heraldic achievements, sometimes on striped or parti-coloured fields. Banners were generally bordered with a narrow fringe, either of gold or of the principal colour and metal of the arms displayed upon it.

Of the curious long and tapering banners called "standards," which were so popular in the 15th and 16th centuries, and of the badges for the display of which they were chiefly used, a very interesting chapter might be written. The whole history of badges is of itself one of great interest, and the facility with which badges lend themselves to artistic heraldic decoration, renders them of peculiar value. A badge is, properly speaking, any figure or device that is assumed as the distinctive mark or cognisance of an individual or family; and it should be borne alone, without any shield, store, or other accessory. A badge, however, may be, and often was, accompanied by a motto. The wearing of a man's badge by his dependents still survives in the "crest" on the buttons of liveried servants, and were the torse or wreath on which it is placed omitted, the "crest" would at once become a badge. Seeing that a crest was pre-eminently the personal device of its wearer, it needs but little consideration to show that what was once an ensign of honour ought not to be degraded to a mark of servitude.

Badges were anciently used as ornaments, or ornamental devices, in every conceivable way and on almost every conceivable kind of object (see figs. 17, 19, 21, 27-30), and now that crests are no longer actually worn, the revival and use of badges is a subject worthy of consideration.

A point that is often overlooked in modern heraldry is the proper way of drawing the various creatures that are used in arms, crests, badges, and supporters. Since heraldry is but a survival of what was once a living thing, it is clear that, if our work is to look well, we ought to draw our animals in a more or less conventional manner. Some creatures, such as dogs, elephants, falcons, &c., may be drawn almost directly from nature; but others, especially lions, if so represented, would be manifestly unfit to consort with the dragons, the gryphons, the double-headed eagles, and other queer creations of the early heralds. The conventional treatment should not, however, be carried to excess, nor should natural forms be too closely copied. Here, as in other matters connected with heraldry, a comparative study of good ancient examples will soon shew what are the best types to follow.

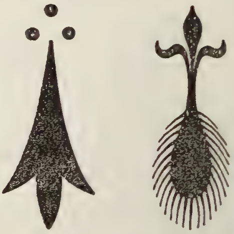

FIG. 22.—Modern and Ancient Examples of Ermine Spots.

It would be an advantage, too, if artists would revert to the old ways of representing the furs known as *ermine* and *vair*. The ancient ermine spots did bear more or less resemblance to a tail torn off an ermine, but the modern object with three dots above it has none. (Fig. 22.) So, too, with regard to *vair*, which actually represents the skins of squirrels, the modern treatment of it as rows of angular 18th century shields is far removed from the conventional form of the real skin seen in old work. (Fig. 23.)

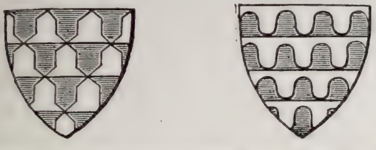

Fig. 23.—Modern and Ancient Examples of Vair.

The treatment of mottoes may not, at first sight, seem to have much connection with my subject, but actually it is one of some importance. There is a good deal to be said for the theory that mottoes are derived from the war-cries of early times, and hence their frequent association with the crest worn on a man's head-piece. In such a connexion the motto should pictorially be represented on a scroll disposed about the crest, as may be seen on divers seals and other authorities. The association of a motto with a shield was not common anciently, and when it is so found it is generally placed on a scroll, like the well-known examples on the Black Prince's tomb at Canterbury. (Fig. 24.) In later times, when shields began to be encircled by the Garter of the famous Order (fig. 25), mottoes were often arranged round the shield in a similar way.

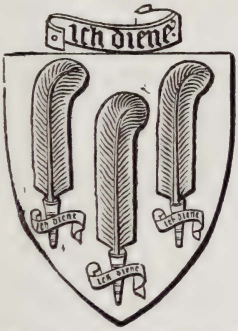

Fig. 24.—Shield of the Black Prince "for peace." From his tomb at Canterbury.

There was, however, always this very important and noteworthy distinction, that the buckled band now so universally adopted was anciently never used for any other than the motto of the Order of the Garter. Other mottoes were written on a band which was fastened in a different way, or merely disposed Garter-fashion round the shield. Two examples, in illustration of this practice, readily suggest themselves: one is on the west porch of the cathedral church of Norwich, where the royal arms of Henry VI. are encircled by the Garter, while the motto of the builder, Bishop William Alnwick (1426-36), is placed on a scroll surrounding his shield of arms); the other case, which is exactly parallel, occurs in the well-known brass of Robert Hallam, Bishop of Salisbury, who died and was buried at Constance, where his brass is, in 1416. (Fig. 26.) The distinction was carefully borne in mind when the insignia of our Orders of Knighthood, other than that of the Garter, were designed, and in every case their mottoes are shewn on plain and not buckled bands. In the Albert Medal for Bravery the encircling motto has been most improperly placed on a buckled band like the Garter.

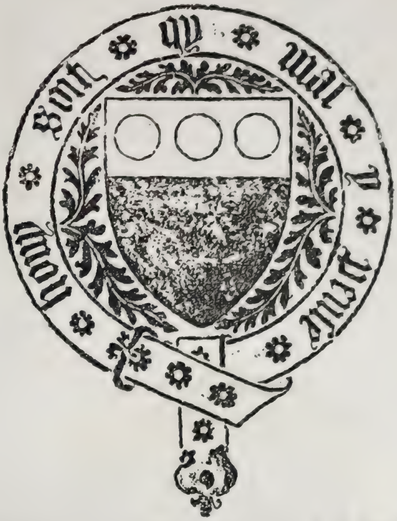
hony soit qy mal y pense

Fig. 25.—Arms of Thomas, Lord Camoys, K.G. (ob. 1419.) From his brass at Trotton, Sussex.

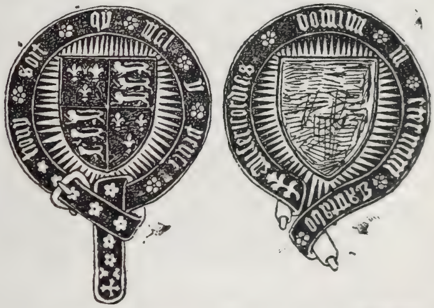
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Fig. 26.—Shields encircled by Mottoes: the one the Order of the Garter, the other of Bishop Hallam (ob. 1416). From his brass at Constance.

The lettering of a motto must of course depend upon the circumstances of its use. Nothing looks so well as the so-called "Old English" or small black letter, especially if the height of the words is as nearly as possible that of the width of the band or scroll, and the capitals are kept down to about the size of the other letters. (Figs. 13, 14, 24-27.) The form known as Lombardic is often preferable for capitals to those of the black-letter alphabet. When capitals alone are used fanciful types should be avoided, a good Roman form, such as is found in Tudor inscriptions, being far better. If the motto is a short one it can be conveniently extended if necessary by a judicious use of ornamental stops, such as roses or other flowers (Figs. 25 and 26). The ends of scrolls with mottoes have a more satisfactory appearance when represented curled up and partly pulled out spirally, than if forked and waved, as may be so often seen now-a-days. The scrolls themselves also look better if they are not bordered or edged in any way, but if this is necessary, as sometimes in the case of enamelled work, the border should be of the smallest possible width.

I have, so far, only referred to the ordinary applications of heraldry, and to the way in which, in my humble opinion, a more artistic treatment might be adopted with advantage. I have also spoken of the difficulty of dealing with the subject satisfactorily within the compass of a brief paper, and to the necessity of studying good examples of heraldic art.

Before showing you a number of such examples on the screen, I would like to call your attention to one of the many interesting facts that a comparative study of ancient heraldry will soon disclose, and that is, the way in which our forefathers, as it were, played with heraldry. They were not content with confining it to its original use as an aid to recognition in the field or in the lists, but on their seals, their weapons, their garments and vestments (Figs. 12 and 30), their jewels, their plate and furniture, their carpets, hangings and cushions, in the windows and on the walls of their houses, in their churches and on their tombs, every kind of heraldic decoration was used with the utmost profusion. With many of these forms of application most of you are familiar from the examples we are still so fortunate to possess, but for some we must go further afield. Where, for instance, can we see the like of the great bed of black satin embroidered with gold roses and the white lions of the House of March, with escutcheons of Mortimer and Ulster, that was bequeathed by Edmund Mortimer, Earl of March, in 1380; or such jewellery as the brooch of Stafford Knots, left to his daughter in 1385, by Hugh, Earl of Stafford? Who could now, like Richard,

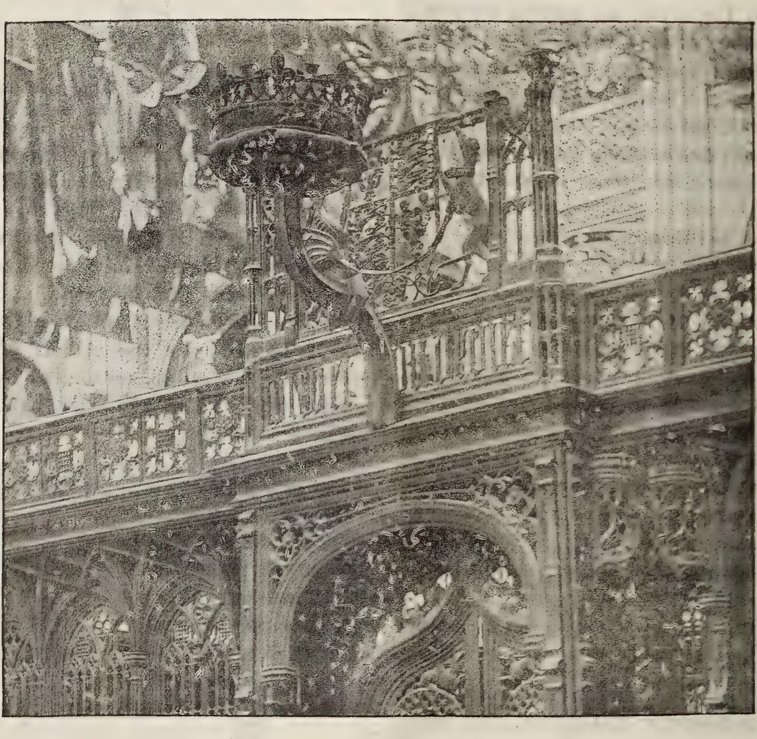

FIG. 27.—Part of the Bronze Grate enclosing the tomb of Henry VII. and his Queen at Westminster, showing the use of badges. The great branch for a candle over the door is fashioned as a crowned Tudor rose.

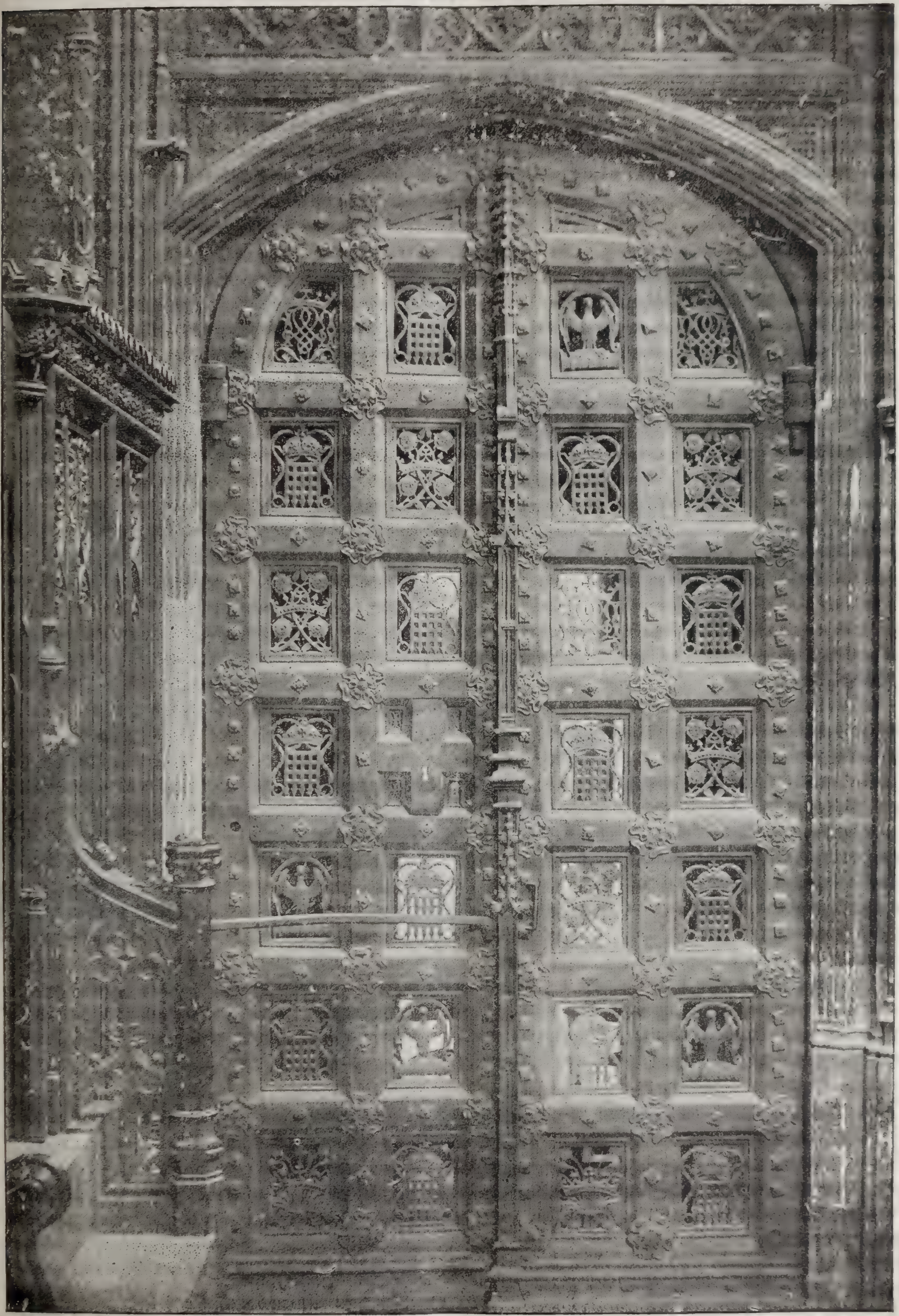

FIG. 28.—One of the Bronze Doors at the west end of the chapel of Henry VII. at Westminster, with Tudor Roses and other Royal Badges.

Earl of Arundel, in 1392, bequeath such articles as a blue bed with the arms of himself and his late wife; the hangings of his hall, of blue tapestry with the arms of his three sons-in-law; and a pair of silver basons with his arms emblazoned at the bottom? We read, too, of such legacies as that of Eleanor de Bohun, the wife of Thomas of Woodstock, of a psalter with clasps of gold enamelled with white swans—the badge of her house (see fig. 29)—and with the arms of her lord and father, and ornamented with gold mullets, such as were borne in her paternal arms. Again, Edward the Black Prince—among other bequests to the cathedral church of Canterbury—left a chalice of gold with his arms on the foot, two basons with his arms, a great gilt and enamelled chalice with the arms of Warenne, and his "halling" of black tapestry powdered with his ostrich feather badge, with a red border with swans with ladies' heads. He also left, for the use of his chantry priests, a mass book and a porthos, which he had caused to be illuminated in divers places with his arms and "our badges of ostrich feathers." (Fig. 24.)

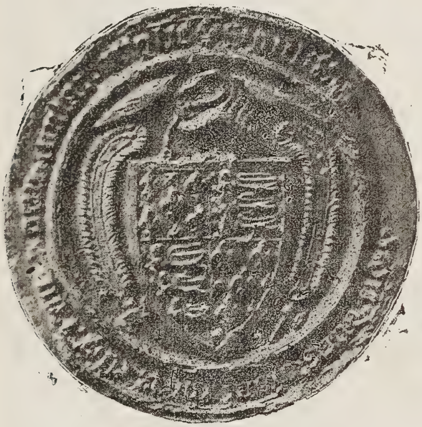

FIG. 29.—Seal of Thomas of Woodstock, youngest son of Edward III., with badges, the Bohun Swan, and ostrich feathers charged with the Garter. Date of Seal between 1385 and 1397.

These are but a few specimens taken quite at random, such as may be gleaned from any collection of wills or inventories; but they are enough to show, with the many examples of heraldic decoration in our churches, our museums, and elsewhere, that our forefathers knew better than merely to paint their arms on the panels of their carriages, or engrave a helmetless crest on their spoons and forks, or emboss the same feeble device on the buttons of their men-servants. This bald and paltry treatment of a really beautiful art, which is generally all that it receives nowadays, ought surely to be amended.

That heraldry is becoming more and more popular daily there can be no doubt whatever, and with its increasing popularity there must come a greater appreciation of its many beautiful forms of application. If there should be concurrently with such a revival a corresponding improvement in the artistic treatment of heraldry, we may yet again see folk so alive to its merits as to wear heraldic ornaments, to embroider their bed quilts with arms and mottoes, and to have their badges woven into their carpets and hangings. People are proud of their ancestral homes, their old furniture, their pictures and plate, why should they not show their pride in their armorial bearings by displaying them in every legitimate and artistic manner?

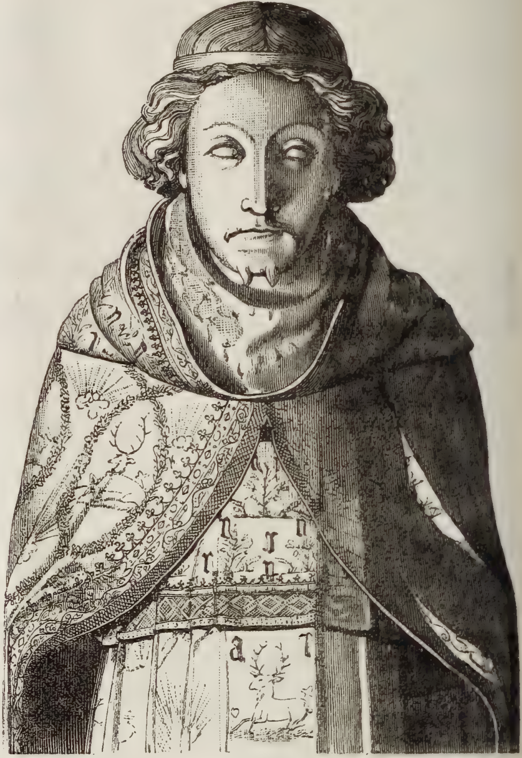

FIG. 30.—Part of the bronze effigy of Richard II. at Westminster, with the robes powdered with the White Hart, the Plantagenet broom-cods, and other badges of the King.

At the conclusion of the paper a number of slides were exhibited on the screen, showing the various applications of heraldry from the 13th century onwards, including its use on seals, armour, horse trappings, articles of clothing, tombs, and architecture generally. A short description of each object was given by Mr. St. John Hope, directing attention to the various points referred to in the paper, which were illustrated by the examples shown. He drew particular attention to the care and artistic skill displayed by the old designers in so arranging the charges as to fairly fill the shield and not leave blank spaces, and pointed out how the practice of introducing supporters had gradually grown up from the necessity of filling up the spaces left on each side when a shield was used as the central figure in a circular field. The various methods of introducing quarterings of different families allied by marriage were also exemplified. In conclusion, Mr. Hope expressed his thanks to Mr. Emery Walker, the Rev. Walter Marshall, Mr. J. P. Gibson and other gentlemen for the loan of some of the slides.

DISCUSSION.

Mr. JOHN LEIGHTON, F.S.A., said Mr. Hope had pretty well exhausted the subject, but there were a few points to which he might call attention. One was the cut sometimes made in the shield to allow the lance to come through, which, in certain cases affected the disposition of the field. In the best period they never put metal on metal, or colour on colour, as was sometimes done now, and they always took care to have the right ground. Diapering, which the Germans were very fond of using down to the present time, when judiciously used, was a great ornament, but it sometimes interfered with the charge. The arms over the National Portrait Gallery door was thoroughly bad, and he thought he had the original of it at home in the shape of the label for Warren's blacking. It was about as good a travesty as Hogarth's, in which he put the lion and unicorn rolling on their backs. In the arms of Scotland there were two unicorns, each supporting a lance with a flag. It was curious how the Jews had taken up with heraldry, but there were only a few instances in which they had used Jewish emblems, and in some cases they had borrowed from the Crusaders, which seemed rather anomalous. The United States flag was adapted from the arms of Washington, and made a very good one, but the French tricolor is awkward to deal with, and some of the best decorations at the time of the Czar's visit, were completely spoiled by the flags; the red, white, and blue not harmonizing with other objects at all. Another curious thing he had noticed was that, in some modern instances, where the garter was used, a lot of ornament was introduced at the end of the strap which would prevent it going through the buckle. Again, he had seen ribbons bearing legends which would be utterly illegible if pulled out straight, the lettering then being on both sides of it. If heraldry were to become a fact something ought to be done to prevent cabdrivers using coronets and crowns of which they were very fond, being untaxed, though nobility itself has to pay two guineas a year. He did not know that there was anything to prevent one using any particular coat of arms. Anyone might adopt the Earl Marshal's arms, and use them as they liked. If it were a trade mark it would be different, he could bring an action, and apparently anyone could protect their arms by simply putting the words "trade mark" at the bottom, and thus save the tax. He was very sorry to say that he once made a drawing of the royal arms, with a lion *rampant* instead of *gardant*, and it was astonishing how it had cropped up again and again; the tax collector now came with a document bearing the arms in that form. It perhaps looked better to have both the lion and the unicorn regarding each other, than one turning away as now and he had sometime thought it would be well to put the unicorn on the dexter side and the lion on the sinister. There were many splendid specimens of blazonry on the sails of ships, and there were also cases in which the shield was tumbled over so as to be *couchant*. It would be very interesting to get a list of all the different kinds of crowns or coronets worn by princes, as they differed very much abroad, some having adopted plants other than strawberry leaves or lilies. With regard to the Archbishops of Canterbury, they had shown a coronet round a mitre for about three centuries, and after such a lapse of time, he thought they were entitled to it and it made a useful distinction between the mitre of an archbishop and a bishop's.

Mr. HUGH STANNUS said the artistic application of heraldry in architecture was a most interesting subject, especially now that the desire to have heraldic bearings seemed again to have come upon the average client. The value of heraldry was very great: it was one branch of the storiation of a building; and told the story of the people who made it, their marriages and inter-marriages, and not only gave the persons but also often the dates. In fact it was one of the most interesting collateral studies that a historian could have. On the question how far heraldry went back they knew the oft-quoted account of the shields of the captains in the Seven against Thebes; but heraldry as we had it came probably nearer at hand from the Mohammedans against whom our Crusaders fought, and he always thought that that beautiful arrangement of colours found in heraldry came from an Oriental race of people who loved colour for its own sake. Some heraldic treatments, such as Counterchange, came from those patterns. He presumed the Crusaders got the idea and improved upon it from the Mohammedans. The application of heraldry was a subject which, if indulged in at all, ought to be indulged in correctly, and the Society was, therefore, much to be congratulated on getting a gentleman who was probably the first expert in England upon this subject, to read this paper, and to shew them such a splendid collection of artistic examples. It appeared to him that when heraldry is applied to architecture it would be applied in spaces which are bounded by rigid lines, as for instance in friezes, panels, spandrils, and features of that kind. That being so: the architect would desire first that it should be of such a nature as to be consistent with the severe geometrical lines by which it was surrounded; that is: it should take cognizance of its environment. He noticed for example in the splendid Percy Shrine that all the heater-shaped shields were rigidly vertical. That showed a certain sense of sympathy with the vertical lines in the columns of the architecture. In some of the other examples, again, there was the severe treatment which seemed to be just the right and proper thing as applied at the time when gothic architecture and heraldry were both in their perfection. And, further, since architecture depended on relief rather than colour: architectural heraldry should have the sense of relief. One way of showing that would obviously be to vary the texture, either to have the face of the shield smooth, and the objects diapered, or to have the objects smooth, and the face diapered. One example had been shown in which both the surface of the shield and the object were smooth, but that did not look nearly so well as the best examples in which the surface was diapered, and the charges smooth. He noticed that in one of the shields shown there was a cross which was diapered, while the ground was left plain; and he would ask whether it would not have been better to have the cross plain and the ground diapered. Everyone who had to do with relief knew that the fretting of a surface tended to make it a tone lower, whereas keeping the surface smooth kept the tone high; and it was obvious that the charge should be the important thing, and not the field. Mr. Hope had spoken about old work being free, and modern work more pedantic, and he was rather sorry for that. One example was shewn in which the animals were made either dexter or sinister, regardless of anything else, merely as a matter of symmetry; but he always understood that there was a rule with regard to that; and certainly in most shields the creatures were towards the dexter side of the shield, and he would like to know if it was intended to convey that this was really a matter of indifference.

Mr. G. Bernard Shaw said there was one practical point he should like to bring before the audience in the hope of eliciting a word or two from Mr. Hope. Of late years there had been an extraordinary number of local public bodies created in this country, including thousands of Parish Councils, and all these bodies wanted to have coats of arms or devices for seals. The question was where they were to get them. This was a distinct opportunity for reviving heraldry as a living art. He understood that there was in existence some preposterous body called the Herald's College, from which you could get a coat of arms for £76 10s. Imagine the ratepayers of a small parish confronted with an item of £76 10s. for a coat of arms! Naturally, the Parish Councils and other bodies preferred to depend on the fancy and imagination of any local artists to whom they might apply for a coat of arms, and he did not know whether that was not really the best way of doing it — whether the spontaneous invention of casual artists was not the way to bring into existence a number of new and beautiful designs Still, he believed some of these bodies have a sort of feeling that if they went to the Heralds' College they would get the right thing (a feeling of confidence which he did not share), and would undoubtedly like to be able to say that they had got their seal from the Heralds' College. He should, therefore, like Mr. Hope to express the opinion, if he held it, that the Heralds' College might make a slight concession as to the fees they charged. For instance, they might set up a special department for supplying arms to public bodies at a reduced rate, say from £2 10s., up to £5.

Mr. J. D. Crace said he should like to call attention to one or two points which had been rather lightly passed over. The great success of heraldry as a matter of colour lay in the simple fact that colour was always on metal or metal on colour. That in itself ensured the absence of any serious discord. In many cases the metal facilitated the harmony of the colour. The next point was the proportion of the charge to the field. Very properly, in several instances, Mr. Hope had pointed out how well the animals filled the shield, and how important it was that the charge should occupy the proper proportion; but he did not tell them what the proper proportion was. The charge should always occupy, as nearly as possible, half the available space, while the ground occupied the other half. Weight for weight, the colour of the field should be an equivalent of the colour or metal of the charge. That ensured harmony. Another point, showing the artistic value of heraldry, arose from the fact that its necessarily more or less brilliant colours formed extremely valuable centres for any system of surrounding decoration. The colouring could always be worked to a satisfactory point of accentuation in the heraldic shields which might be introduced in the architecture of a building, when it was at all coloured. Mr. Hope might be interested to know that he had himself a complete series of the plates of the stalls of St. George's Chapel, drawn at the beginning of the century, and coloured after the plates. In speaking of the origin of the mantling of the crest, it was not often enough realised that that at least had its origin in the crusades; the necessary protection from the sun to the head of the wearer necessitated his wearing that, of which the Arabic *kufieh* was the modern equivalent. The shape of the *vair* was a little interesting, because it, in fact, represented the making up of a fur cloak; and the long shapes, something resembling inverted shields, were nothing more than the skins of grey and white squirrels, with the remains of the legs spread out. This gave a sort of connection to the name of *vair*. It was used for colour, but the name *vair* was simply fur, which had another curious traditional connection with the famous slipper of Cinderella, which, in the English version of the fairy tale, was always spoken of as a glass slipper, because it was a slipper of *vair*, that is to say, fur, not glass. Perhaps that was not quite settled, however. The great point was, that heraldry should be dealt with in a proper spirit; not attempting to introduce in coats-of-arms all sorts of devices representing landscapes or pictures; but the necessity should be recognised of simplicity, and also drawing the object, whether animal or whatever it be, so as to adapt it to the space which it had might to occupy. They must also recognise the great value of heraldry in any scheme of colour decoration which admitted of its introduction.

Mr. H. B. WHEATLEY said, with regard to Cinderella's slipper, that Mr. Crace's view as to its being made of fur rather than of glass was at one time generally held, but, he believed, it had now been satisfactorily proved that this was a mere suggestion of the learned, without any substantial foundation.

The CHAIRMAN said Mr. Hope had referred to the awkward shape of the lozenge shield used by ladies. There was no doubt about its inconvenience; and he should like to know whether it was obligatory. The artist was continually hampered when dealing with heraldry by being told that he must do this, and he must not do that; he should like to know whether the lozenge-shaped shield was a thing one must accept as a necessity, or whether they had a right to shape it as they liked. Was it a law, or might one kick against it. With regard to the mantling which Mr. Hope said was originally in red and ermine, he had had it always drilled into him that the colour of the mantle should be the two colours preponderating in the shield, and he should like a little further instruction on that point. Again with regard to the Bishop who removed one of three birds in his coat of arms and put the mitre in place of it, he should like to know whether he was entitled to take other such liberties; might he have put his three birds and the mitre as well? With regard to diapering, several reasons had been suggested for its use. One distinct use of it was to qualify colour. If you were emblazoning a shield yourself, you could make the colour what you liked, so long as you kept to the "tincture," though nowadays people insisted on crude colours, under the supposition they were heraldic. But in any case the shield would probably have to be repainted some day; and, if the artist thought about it, he knew that when repainted it would probably be painted in a crude colour. Supposing it were diapered the quality of that colour would, however grossly coloured, be improved immensely, especially after a little time when dust and dirt had settled in the incised parts. In that case, then, diapering would be of distinct use. Mr. Stannus had said with regard to a certain shield shown on the screen it would have been better to diaper the ground than the cross; but he thought Mr. Hope had told them that the cross was in gold, and there was a distinct reason for diapering gold; you wanted to break the surface, to make the gold sparkle; there was, therefore, a legitimate reason for diapering the cross in that instance instead of the ground. He understood Mr. Hope to speak against the ends of scrolls being forked and waved, and to say that it was better if they were simply rolled up. The way the modern man treated the scroll or label was, no doubt, horrible; but he should be sorry to give up the beautiful scrolls of some of the German heralds, such as Burgkmair and Durer, who introduced them in the most delightful way. They had seen some fine examples that evening, but, after all, the best heraldry was made in Germany in the Middle Ages; and the Germans had kept up mediæval traditions, more or less, to the present time. One great source of satisfaction to the speaker had been to find that a learned antiquary, an authority on heraldry, could be absolutely free from pedantry—and had told them, indeed, that the artist might, within certain limits, do as he liked. After all, heraldry was symbolism, a kind of picture writing; there was no mystery about it; all you had to do was to use your intelligence and to make yourself intelligible. That was most encouraging information; it was something to be grateful for. He proposed a cordial vote of thanks to Mr. Hope for his interesting paper.

The vote of thanks having been passed,

Mr. St. JOHN HOPE, said he had carefully guarded himself at the outset by saying that he assumed most of them knew the grammar of heraldry, such as could be picked up from any decent manual, and some of the remarks which had been made really fell within that limit. The point Mr. Leighton raised as to shields *a bouche* was included in what he said about shields of different forms. With regard to the coronet round the Archbishop of Canterbury's mitre, that was heraldic in a way, but it was entirely modern. There was no instance of it before the Restoration, and it was purely the inven tion of coach-makers. They probably heard the Archbishop called "Your Grace," and thought that he ought to have a coronet round the mitre. With regard to Mr. Stannus's point about diapering, the Chairman had anticipated his reply. The fact that the cross was gold was a reason for its being diapered. The origin of heraldry was a very large subject on which one might write a very long paper, and then people would get up all over the room, and contradict one point after another, and say that so and so who knew quite as much about it held a different opinion. He did not, therefore, care to go into it at all, it was quite enough for the present and for all artistic purposes to know that whatever its origin was in this country they found heraldry treated as a science and an art at about the be ginning of the 13th century, and it had continued in a more or less crystalised state ever since; it had only varied from time to time in an artistic direction. With regard to the adoption of arms and badges by county and parish councils, he held that none of these bodies had the smallest right to have arms at all. To begin with they were not corporations, and even if they were he had still to raise the same objection. He held it was quite anomalous for the City Companies to have arms, but they were in several instances granted to them by the Heralds as long ago as the middle of the 15th century, when heraldry was still a living art. One of the things he had never been able to explain was, how heralds could grant arms to the Companies, and still less crests, as some of the Companies had. An individual could wear a crest, but a City Company could not. It was one of the heraldic anomalies you did meet with occasionally. With regard to the jurisdiction of the Heralds' College he himself held views on that point with which he would not trouble them. There were people who thought that anything the College did was right, and that the Heralds were the sole fountain of honour and the only people who had any right to make a grant of arms. There were, however, many grants of arms made long before the Heralds' College came into existence. He had in his own possession a grant made under the great seal of Edward IV., before the Heralds' College came into being at all. Mr. Crace's remarks were very interesting, but the question of colour was part of the grammar of heraldry. He did not quite agree with him as to the existence of a medivæal rule for proportion between metal and colour portion, and considered that being tied down by strict rules was one of the things which had thoroughly ruined heraldry during the last two centuries. Mediæval artists would not restrict themselves in that way. They drew crosses of all widths and fesses of all widths; and would scarcely have thought of cutting a shield into four and giving two of the compartments to the fesses, and the other two to the field.

Mr. CRACE said that was not what he intended to suggest. It was that the charge should occupy approximately the same amount of space, not in any particular corner of the field, but the same proportion of the surface as was left of the field. That was the case in the best illustrations exhibited by Mr. Hope.

Mr. HOPE said that the rule was difficult to follow when you came to simple ordinaries. When the field was covered with charges the rule might hold good. It was a curious fact, that shields of arms always did look well, whatever they were upon, and wherever they were put. He had taken a simple shield, and placed it on all sorts of crude colours of the most violent contrasts, but it always held its own, and looked well. With respect to the use of of lozenges, he could tell the Chairman that he might really kick as much as he liked against them; and he could find many instances in good mediæval art where a lady's arms were not placed on a lozenge at all, but on a shield, just the same as a man's; in fact, on the tomb of Eleanor of Castile there were no lozenges, and there were plenty of other exceptions. With regard to mantling, he believed some heraldic manuals did lay it down that it should be of the principal colour and metal; but that certainly was not the rule in mediæval times. If you took a long series, like the plates in St. George's Chapel, it would be found that they were usually red—no matter what the field was—and lined with ermine. There were also cases where it did follow the colour of the metal and the arms. He had even found them with the colours different on either side.

The CHAIRMAN asked if an artist might take colours to suit the general colour scheme of decoration.

Mr. HOPE said there was mediæval precedent for it. With regard to Bishop Grandison altering his arms by substituting the mitre for one of the eaglets, there were hundreds of examples of that sort of thing. As he had said before, the mediæval men played with heraldry. So long as the armorial bearings of the family were not altered into those of somebody else by the alterations made, it did not matter. In the particular case of Bishop Grandison, everybody knew what the Grandison arms were, and the mere change of one of the charges made an alteration that only affected him personally. With regard to the scrolls, it was only the ends he referred to. The twisting-up form was better than forking the ends, but you might make the scroll curl about as much as you pleased, and the Germans did that very beautifully. For decorative purposes, German heraldry was much more florid than English, and in some points better. Our artists always treated heraldry more soberly and quietly. With respect to the unique series of stall plates in St. George's Chapel, the set of photographs he had shown was the first that had ever been taken, and probably it would be the last for a long time to come, because of the difficulty of getting the plates down to photograph them. They were also very difficult to photograph, inasmuch as many were covered with a coating of varnish. There was a set of tracings of the whole series in the Heralds' College, and Sir Wollaston Franks also had a number of coloured drawings, but he had never seen any drawings which gave a correct idea of the originals, except the few in Anstis's "Register of the Order of the Garter."

TENTH ORDINARY MEETING.

Wednesday, Feb. 17, 1897; The ATTORNEY-GENERAL, G.C.M.G., Q.C., M.P., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society :—

English, Thomas Matthew, H.H. the Nizam's Mint, Hyderabad, Deccan.
Furse, Alfred C., Montpelier, Brecknock-road, N.
Gardner, Robert, 20, Lloyd-square, W.C.
Lloyd, Thomas, 99, Earl's-court-road, Kensington, W.

The following candidates were balloted for and duly elected members of the Society :—

Page, William, F.S.A., The White House, St. Albans.
Warwick, J. B., Messrs. Mackenzie, Lyall and Co., Calcutta.
Wolfenden, Thomas, 54, Hall-street, Southport.

The paper read was—

THE BARSI 2 FT. 6 IN. GAUGE LIGHT RAILWAY.

BY EVERARD R. CALTHROP.

THEORY OF NARROW GAUGE LIGHT RAILWAYS.

The traffic to be carried in any district through which a railway is about to be constructed, is the same whether the proposed railway be built on the standard gauge or on a very narrow gauge; but the revenue which might result in an actual loss on the working of the former, may be made to produce a satisfactory return on the much smaller capital of the latter. The object aimed at by the advocates of light railways of very narrow gauge is the provision of railway communication on a remunerative basis, in countries and districts where the traffic to be carried is considerable, but insufficient to produce a proper return on the capital required for a railway of normal type.

2. To attain this object the fundamental idea of light railway construction and working is the elimination of every kind of expenditure which is non-essential to its efficiency as a means of transport, and the reduction of all permanent way, plant, and appliances to their simplest and most inexpensive forms.

3. The reductions in cost of permanent way, obtained by the use of lighter rails and smaller sleepers, are supposed by many to be the only advantages that are offered; but while the gains under these heads are not inconsiderable, they are really the least of all. The principal savings in capital cost effected by narrowness of gauge, occur through the much greater flexibility of its alignment as compared with that of the wider normal gauges. The established minimum radius of curves on open line, and in sidings or difficult country, is for the several gauges respectively as follows :—

MINIMUM RADIUS OF CURVE.
Indian Practice.

Gauge.			Radius in ordinary country.	Radius in sidings or difficult country.
	Ft.	in.	Feet.	Feet.
Standard ..	5	6	1,600	600
Metre	3	3⅜	1,000	400
Special	2	6	250	150
	2	0	150	60
English Practice.				
Normal	4	8½	1,320 = 20 chains.	462 to 660 = 7 to 10 chains

The small radius of the curves of the narrowest gauges confers immense advantages in locating the alignment of a light railway. Its flexibility permits it to wind in and out to avoid deep cuttings, heavy embankments, and the severance of valuable property, and if required to follow all the convolutions of an ordinary road. Tunnelling, heavy rock cuttings, and steep gradients can often be avoided by a quick detour quite impossible on the standard gauge; the latter by the greater stiffness of its alignment is often compelled to plough through buildings and other valuable property, and to construct bridges and other expensive works, which otherwise might be avoided. The extraordinary cheapness in capital cost of the 2 ft. 6 in. gauge lines built in India is explained chiefly by this avoidance of costly obstacles, and the utilisation of long reaches of ordinary roads which Government has permitted them to use free of cost.

4. Compared with the possibibilities of standard gauge rolling stock, the cost of carriage stock, per passenger seated, and of wagon stock, per ton of load, is somewhat less. As compared with the standard gauge wagon stock actually in existence, the cost per ton of load is very considerably less. The cost of locomotives per ton weight and per indicated horse-power is, as one would expect, rather greater on the narrow gauge.

5. In designing the permanent way and rolling stock for a narrow gauge light railway, the principal object to be aimed at is to obtain the greatest proportionate traffic capacity, from the cheapest possible track. Everything must be made subsidiary to the cheapening of the track. Any additional costliness of the

rolling stock, as will be shown later, is as nothing if it results in any considerable reduction of the weight, bulk, and cost of the track.

6. On any kind of railway, the cost of track must be the principal consideration, for it is obvious that, if it is possible to quadruple the length of the track for the same expenditure of money, by so doing the traffic area of the line is also quadrupled. In other words, a narrow gauge light railway, laid down at one-fourth the cost of the standard gauge per mile, is sixteen times more efficient as a revenue producer, than a standard gauge line costing the same amount, by means of its being four times as long and carrying four times the traffic over the additional length. I am speaking of course of conditions where the traffic is an even quantity and proportional throughout to the length of the line, and where the cost per mile is fairly even throughout its length. Such conditions, from a variety of causes, are comparatively rare in England, but in other countries possessing large areas unoccupied by railways, they are by no means infrequent.

7. It follows then, under these conditions, that a very narrow gauge line being able, with the same expenditure of capital on track, to earn sixteen times the revenue of a standard gauge line, it can afford theoretically to run through country so poor that it produces but one-sixteenth of the traffic, that would be necessary to obtain a remunerative return on the capital of a standard gauge line if constructed through the same country.

8. After what has been said, it is hardly necessary to point out that the prospects of any light railway improve directly with its length. The longer the run the greater the traffic and the cheaper it can be worked. If a light railway, constructed at a minimum cost per mile, should not make an altogether satisfactory return on capital, the surest remedy is to extend it.

DEMONSTRATION OF THE CORRECTNESS OF THE THEORY.

9. How is this theoretical superiority of narrow gauge lines as dividend-earners borne out in practice?

In India, as is well-known, there are now four gauges—the standard, 5 ft. 6 in.; the metre, 3 ft. $3\frac{3}{8}$ in.; and two special gauges, the 2 ft. 6 in. and 2 ft. In these last days of the century, with the results of 60 years of railway progress behind us, it is difficult to understand the failure 50 years ago of the Government of India to appreciate the certainty of the linking up of the European and Indian railway systems, which is now on the threshold of events. The original gauge, unfortunately selected as the standard for India, was the 5 ft. 6 in. At a later date, it was discovered that the costliness of the 5 ft. 6 in. gauge was an absolute bar to the extension of railway communication in certain of the poorer districts of India, and after much agitation and consideration, the metre, or 3 ft. $3\frac{3}{8}$ in., gauge was eventually sanctioned for lines which were held to be of minor importance strategically, which generally fully bore out the anticipations of their supporters.

More recently again, attempts were made to obtain a still cheaper form of railway in districts where even the metre gauge could not be laid down remuneratively, with the result that after a still greater resistance on the part of the authorities a number of short lines have been sanctioned and constructed on the 2 ft. 6 in. gauge.

10. There is perhaps no country in the world where railway statistics are as carefully registered and collated as in India, and there is certainly no more interesting production published by any Government than the administration report on the railways in India, which is characterised by intelligent analysis and extreme accuracy.

In this report statistics of the working of the standard, metre, and special gauges are dealt with separately, so that I have been able to represent the general results of the working of all railways in India grouped according to their gauges. The Table (page 247), in which the ultimate influence of gauge upon capital cost, working expenses, and net profits is shown to be of a most remarkable character, affords the completest justification of the policy of the Secretary of State in anticipating the recent legislation in England by permitting the construction of railways of a smaller gauge than the normal, in districts where the traffic is insufficient to support a railway of standard type.

11. The facts disclosed by the figures as they relate to the three gauges are as significant as they are unimpeachable. As compared with the average cost of the standard gauge, it is shown that the average cost of a metre gauge line is rather less than one half, while the cost of a 2 ft. 6 in. gauge line is actually only one-fifth. These figures include rolling stock and

General Results of the Working of all Railways in India for the Year ending December 31st, 1895.

Particulars.	Standard Gauge. 5 ft. 6in.	Metre Gauge. 3 ft. 3 in. & 3 ft. 8 in.	Special Gauges. 2 ft. 6 in. & 2 ft.
Capital Cost:			
Average cost per mile open (rupees)	1,58,730 Rs.	71,121 Rs.	32,950 Rs.
Ditto, at exchange, 1s. 3¼d.	(£10,095)	(£4,519)	(£2,093)
Passengers:			
Passenger unit miles per mean mile worked (unit miles)	368,456	264,351	93,943
Average distance of journey (miles)	41·9	37·6	27·1
Goods:			
Goods, ton miles, per mean mile worked (ton miles)	358,028	124,511	16,364
Average distance carried (miles)	156·1	119·2	34·1
Working Expenses:			
Per-centage of working expenses on gross earnings (per cent.)	45·14	49·12	53·16
Net Profits:			
Per-centage of net profits on total capital outlay on open line (per cent.)	5·78	5·73	7·67

all capital outlay whatever. But taking into consideration the circumstance that when the older standard gauge lines were built there was a higher range of prices for rails and rolling stock, we are nevertheless face to face with the fact that for the same expenditure of money it is possible to construct and equip four hundred miles of 2 ft. 6 in. gauge at the cost of one hundred miles of standard gauge. In India, at all events, it is not open to doubt that a line of narrow gauge, carried to a distance of a hundred miles, must produce, in its combined capacity as a feeder to the main trunk line, and as a distributor of English merchandise, a much greater effect upon the development of of an unopened district than a standard gauge branch of 25 miles, with 75 miles of cartage behind it. The extra length of the line secures for the benefit of the country much cheaper carriage, and, for itself, a much greater traffic catchment area. The cost of transhipment at the junction with the main line, which however can be altogether avoided by an appliance about to be described, is as nothing compared with the cost of carriage over the additional 75 miles of line which can be laid for the same money.

12. The next and most important result which the Table makes clear is that the 2 ft. 6 in. gauge running through the poorest districts, for short distances only, with a passenger traffic per mile of less than *one-fourth* that of the standard gauge, and with a goods traffic per mile only *one-twentieth* that of the standard gauge, is not merely able to survive, but can actually show a greater per-centage of net profits on total capital outlay, than the standard gauge trunk lines running through the pick of the country, and backed by all their great volume of arterial traffic, carried over long distances. The above results illustrate in the most practical manner the concrete effect of the multitude of small advantages gained by the adoption of a very narrow gauge, and fully demonstrate the correctness of the claim made for it that such a line is able to run with satisfactory financial results through country producing but a very small fraction of the traffic required to obtain a reasonable return on the capital of a standard gauge line.

13. It is as well to point out that there is a great principle underlying the question of gauge. *A railway is a machine, and like any other machine, is economical only when working within a reasonable measure of its full power.* In the recognition and observance of this in principle lies the whole art and mystery of the financial success which has attended the working of narrow gauge lines on the Continent and in India, in districts where a standard gauge line would not only starve, but would lose money to the end of the chapter.

HISTORY OF THE BARSI LIGHT RAILWAY.

14. The main points in the history of the Barsi Light Railway may be of interest to you as exemplifying the difficulties which have attended the introduction of light railways in India, and of this project in particular.

15. The Barsi route, as the main line of traffic between the dominions of His Highness the Nizam of Hyderabad and the Port of Bombay, has existed from time immemorial. Previous to the construction of the G.I.P. Railway, the traffic was carried down to Bombay in bullock carts and on pack animals. In the year 1856, the existing rough cart track was converted into an unbridged and roughly ballasted road with the result of a great increase in traffic. After the construction of the south-east branch of the G.I.P. Railway in 1860 the traffic increased further to an average of 500 carts daily. In 1862, proposals were submitted to the Government of Bombay by the Chief Engineer of the Bombay Presidency for the construction of a bridged and embanked road to be traversed by a light railway. In 1870, the road and bridges were constructed, but the Government of Bombay did not find themselves in a position to incur the cost of the light railway. The improved condition of the road was followed however by a further great increase in traffic. In 1878 the Government of Bombay proposed to the G.I.P. Railway that a branch line to Barsi should be constructed as an extension of their system, and surveys were made in 1880 and 1881, but after all preparations had been made the Secretary of State finally informed the company that he was "not disposed to enlarge the operations of the company under any arrangement which would involve any extension of the guarantee of interest, or, of the grant of pecuniary assistance to the company from the State in any shape." The project of the branch as an integral portion of the G.I.P. system was therefore abandoned. A subsequent proposal that the line should be constructed by Government as a provincial railway and worked by the G.I.P. Railway was introduced in 1882 by the Government of Bombay, and abandoned in 1885, with a notification that since Government found itself unable to advance the capital required the line should be undertaken by private enterprise.

16. In 1887, being Assistant Locomotive Superintendent on the G.I.P. Railway, I undertook a preliminary survey, and having satisfied myself as to the prospects of traffic, applied to the Government of Bombay for the concession to construct a line along the existing road from Barsi-road Station on the G.I.P. Railway to the town of Barsi, a distance of 22 miles, on the 2 ft. 6 in. gauge, without any guarantee of interest. The negotiations with Government were continued without intermission from March 1887 until July 1895—a period of more than eight years—during which I arranged three times for the capital required, and expended £6,300 in surveys, estimates, and two special visits to India, involving together an absence from England of two years and ten months. It has been an experience which I do not wish to repeat, and although no guarantee or financial assistance whatever had been asked for, it cost over £260 per mile of line, merely to obtain the concession on these terms.

17. In looking back on these protracted proceedings my pleasantest recollections are of the help extended to me by the consulting engineers to Government and of others who were in entire sympathy with the system which I advocated. Without their energetic assistance it would have been impossible to have overcome the influential obstruction which then existed. It is pleasing however to be able to state that the resistances have now disappeared, and that the much talked of "Encouragement of private enterprise," which for many years had been a mere snare and delusion is now becoming an accomplished fact.

TRAFFIC ON THE BARSI LIGHT RAILWAY.

18. Before proceeding to describe the nature of the permanent way and rolling stock which I have designed for the Barsi Light Railway, it is desirable to give you an impression of the traffic to be accommodated. I now place upon the screen a map of the Barsi Light Railway and a portion of the map of India showing its connections with the existing railway system. As will be seen we are putting a small feeder line into a tract of country as large as the whole of England and Wales, which up to the present is totally unprovided with railway communication of any kind. The town of Barsi is the central mart of the trade to and from the great expanse of territory in the valley of the Godaveri belonging to His Highness the Nizam of Hyderabad, which territory is cut off from any access to the G.I.P. Railway for nearly 100 miles by the rivers Bhogavati and Sina, except through Barsi.

Complete records of the traffic received at the Barsi-road Station have been kept for many years; as also of the traffic passing through Barsi town. For the five years ending December, 1894, the average goods traffic at Barsi-road Station, passing over the G.I.P. Railway, amounted to 77,599 tons per annum, of which 95 per cent. was estimated to pass through Barsi town—an estimate which agrees with the municipal records. Since the year 1881—the first of which I possess complete records—the largest traffic occurred in 1891, the amount being 107,000 tons; and the smallest in the year 1888, the amount being 51,000. The import traffic from Bombay averages one-third, and the export traffic from Barsi two-thirds, of the total tonnage. The extent of the area served by Barsi, as a centre of distribution, will be better realised from the fact that the average weight of salt imported for human consumption alone, during the above-mentioned five years, exceeded 7,000 tons annually. Other imports than salt consist chiefly of iron and other metals, machinery, mineral oil, silk and cotton piece goods, and twist and other European products. The principal article of export is cotton, of which the output in several seasons has exceeded 90,000 bales of cotton of 3½ cwt. each, pressed at Barsi. The remaining exports are wheat, linseed, ground-nuts, native food grains of all kinds, gingelly and other oil seeds, indigo, dyes, sugar, spices, wool, hides, and skins. The passenger traffic, including pilgrims, over the road traversed by the light railway, amounts to about 200,000 each way per annum.

19. The means of transport between Barsi and the G.I.P. Railway has been confined entirely to bullock carts, carrying from 6 to 12 cwt., according to the nature of the goods. In the busy season, from 1,000 to 1,500 carts leave Barsi daily for the station. Beyond Barsi bullock carts are employed where the roads are fairly good, but pack animals, carrying from 1 to 2½ cwt. each, are still used to some considerable extent.

20. My first five photographs, which will now be put upon the screen, show the export goods shed at Barsi-road Station, with the bullock carts arriving from Barsi. This shed is filled and emptied daily, all goods being loaded into railway waggons and the shed cleared before night. The size of the shed, which is 396 feet long, gives some idea of the proportions of the traffic moved.

The next photograph shows the exterior of the import goods] shed, and the next its interior, containing one day's import traffic unloading from railway wagons, and ready for carting to Barsi town. This shed is filled and cleared daily, and is 300 feet long.

The next view is that of the export goods shed from the opposite side, showing three parallel lines of sidings filled with empty goods wagons, ready for the day's export traffic.

The next four views show the continuous stream of traffic met when travelling to Barsi town. They also show the great width and solid construction of the road, and the suitability of such roads for the construction of a narrow gauge railway along the side.

The next two photographs show the character of the embanked portions of the road. The two following views illustrate contingencies of cartage which we as carriers expect to avoid.

The next two photographs show the maximum gradient on the road, which occurs in a rock cutting, and is one in ninety. The rock cutting was made for the original light railway proposal of 1862.

The two following slides show the large bridge of eleven spans of 48 ft. over the river Sina. This is the principal river which cuts off the traffic from the G.I.P. Railway during the monsoon. These slides illustrate the character of Indian river beds in the dry season, which has led to the proposal for fair weather lines, which could be constructed extremely cheaply without bridging and would be closed during the monsoon months, when but little traffic offers. The rails would be laid on "Irish" bridges, which are covered during floods, or direct in the river bed, and be removed before the monsoon.

The next four slides exhibit the types of the remaining bridges, all of which together with the large Sina-bridge have had to be strengthened. This, unfortunately, together with the great difficulty we have had in obtaining freight for our rolling stock, owing to the practical cessation of exports from India, had delayed the opening of the line beyond the period originally anticipated.

The next four views are of Barsi town showing the grain traffic in the streets.

Mention has been made of the cotton presses in Barsi. The first view shows the exterior of the Moolji Jetha Cotton Press, and the second the interior. The third shows the Prince of Wales Cotton Press, with extensions in progress. The fourth shows the stacks of firewood used for the boilers of the various cotton presses, and is interesting in view of the prospective coal traffic from the Singareni mines, which will now supersede the use of firewood altogether.

The following five slides are of traffic on the road beyond Barsi, and show the unpressed cotton coming to Barsi from Latur, 68 miles distant, to which place we hope shortly to extend our undertaking.

The next two views show the pack animals which bring traffic into Barsi from parts where there are no roads.

I close the illustrations of the Barsi traffic by seven photographs of the Barsi cotton ground, where the cotton lies waiting to be pressed. The last six photographs, which form a disconnected panorama, were taken from the position shown in the first photograph, and give a fair idea of the magnitude of the cotton traffic. The iron smoke stacks in the background indicate the positions of the various cotton presses.

THE BARSI PERMANENT WAY.

21. In the selection of the most suitable gauge for the Barsi Light Railway many considerations had place. It was essential, in view of the very large existing traffic and of its subsequent expansion, that its ultimate traffic capacity should be very great. On the other hand, it was equally necessary that the cost per mile of permanent way should be so small that it would pay us to extend the line into localities where the traffic was comparatively insignificant, and that we should also be in a position to offer special siding accommodation with considerable generosity. It is accommodation and convenience which attracts traffic nowadays, and the ability to run sidings, at a comparatively trifling cost, into the cotton presses, warehouses, godowns, and compounds so as to eliminate all avoidable handling and cartage, all tends to develop trade and increase the traffic over the main line itself. These, and the considerations enumerated at the beginning of this paper, originally led me to select the 2 ft. 6 in. gauge as the best for the purpose, and the more I know of it the better I like it. There is no doubt that, as compared with all others, it is the gauge possessing the *greatest carrying capacity per cent. of cost of track.* It has sufficient stability to carry goods of very great weight and bulk, while the flexibility of its alignment is such that it can accommodate itself to country of the most mountainous and difficult character, at a fraction of the cost of a standard gauge line negotiating similar difficulties.

The two following photographs show the character of works required for hill-climbing on broad and narrow gauge respectively. The first is the reversing station at the Bhore Ghaut, on the G.I.P. 5 ft. 6 in. gauge railway, showing the heavy masonry required, and the second is a loop answering the same purpose on the 2 ft. gauge Darjiling - Himalayan Railway. The visible contrast between the cost of such works is very striking.

22. After the selection of gauge, the next point was the minimum weight of rail and the maximum load to be placed upon it. This, with the concurrence of the Secretary of State for India, I fixed at 30 lbs. per yard and 2½ tons respectively, giving a maximum load of 5 tons per axle. On the length to Barsi town, the weight of rail actually laid down is 35 lbs., but this has been merely a matter of economy in maintenance under an extra heavy traffic. For branches or sidings where the traffic is comparatively light we have utilised the 30 lb. rail only.

In the 30 and 35 lb. Barsi sections the head of the rail is of the same width, the extra metal in the latter being put principally on the top of the head. The head is made particularly wide with the object of providing ample bearing surface and preventing grooves being worn in the tyres. Most sections of light rails err in this respect, with the consequence that they cut the tyres badly. The sleepers are of stamped steel weighing 40 lbs. each. The sleepers have been spaced at distances so arranged that there is equal resilience both as regards rail joints and throughout the intermediate length of rail. This practice was first determined by theoretical considerations, the correctness of which was afterwards demonstrated by a series of lever experiments, conducted on the permanent way by means of a lever-testing machine, and finally by practice. At the Newlay Exhibition the smoothness of the track laid on this principle was generally remarked. The points and crossings are 325 feet radius, the angle of crossing being 1 in 8, and can be laid down either as right hand or left hand turn-outs. The intermediate rails are bent, cut to sizes and fitted, and are shipped complete with each set, so that, on arrival, they can be laid exactly as they are.

The following slides illustrate in a somewhat graphic manner how a saving of expenditure is effected in permanent way, as contrasted with that of standard gauges:—

(*a*) A section of the Barsi 30 and 35 lb. rail compared with the 90 lb. rail in use on the London and North-Western Railway; (*b*), a 24 ft. length of Barsi permanent way with differential spacing, compared with a 30 ft. length of 4 ft. 8½ in. gauge permanent way; (*c*), cross sections of permanant way of the 2 ft. 6 in., 4 ft. 8½ in., and 5 ft. 6 in. gauges; (*d*), lengths of Barsi permanent way exhibited at the Newlay Exhibition, showing the manner in which steel sleepers are nested for shipment and rail carriage; (*e*), scissors crossing, showing construction of points and crossings; (*f*), scissors crossing, showing diamond crossing in centre.

23. Before leaving the subject of permanent way, I wish to emphasise the necessity, in regard to light railway work, of abandoning the extremely high standard of construction considered necessary, on standard gauge railways, and adopting a standard which, while it takes nothing away from the efficiency of the line as a means of transport, reduces the cost per mile to a very appreciable extent.

One of the advantages of the 2 ft. 6 in. gauge is that it requires no raised platforms. All that is necessary is a well drained gravelled space, edged with stone slabbing to mark its boundaries. Compare this with the cost of paved platforms raised 2 to 3 feet above rail level for a length of 600 to 800 feet, to which is added the cost of the extra height of the foundations of all station buildings placed upon such platforms. On the standard gauge such platforms are practically a necessity on account of the great height of carriage and waggon floors above rail level. Illustrating these remarks I show two views; the first of Kalyan Station on the G.I.P. 5 ft. 6 in. gauge railway. and the second of Vathar on the Southern Mahratta metre gauge railway, both with long lengths of raised platform. The next view is of Salarwady, a roadside station where no platform has been erected. For light railway work I am against all ornamental and unnecessary expenditure. The two following slides illustrate my point. The first is a native gate-keeper's hut, at a road crossing on a metre gauge railway, built by himself, and in which he would have been content to live until further notice. The second is the ornamental, but from the native point of view, much less comfortable "pukka" erection to which he was compelled to migrate on its completion. At least twenty native huts could have been built for the cost of the latter.

24. In my opinion, the fact that it is essential to their financial success that narrow gauge light railways have to be built and worked on principles and guided by rules totally divergent from those in use on standard gauge railways, is a very strong argument in favour of their independent administration. The whole bent and training of the rank and file of the staff of a standard gauge line is towards solidity and lavish expenditure, and with the advent of heavier train loads and higher speeds, this tendency will become more and more pronounced. The metier of the light railway man is, on the other hand, to eliminate expenses, superfluity, and complexity in every shape and form, and to evolve a type of line on which efficiency of action is combined in every department with the greatest simplicity of equipment. To place the working of a narrow gauge line, on which such a policy is required, in the hands of a staff furnished, changed, and controlled by an adjoining standard gauge railway, and to expect it to carry out a *rôle* totally opposed to all its previous traditions, is not likely to produce the desired results, and, so far as I am aware, has never yet done so.

25. As it is practically impossible to effect any useful reductions in the cost of standard gauge permanent way, I am satisfied that, if any considerable development of the light railway system is to take place in England, it must be on the narrow gauge, so as to obtain the full maximum advantage as regards first cost. In this event, it is of the very greatest importance that one standard gauge should be fixed for such narrow gauge lines, so that rolling stock may be interchangeable. It is inevitable that light railways, although beginning with isolated projects, will join up to one another. I go further than this, and say that light railways in England will be as unsuccessful financially as those in Ireland unless some central organisation can be brought into being to undertake their management and working. The inordinate management charges following on the independent direction of undertakings of extremely short mileage, together with the abnormally heavy capital cost per mile of the Irish 3 feet gauge light railways, are responsible for the generally unsatisfactory character of returns on capital invested. Greatly improved results would follow were all these Irish light railways to be amalgamated into one large undertaking, so that the proportion of management charges to other charges could be reduced, together with the cost of the maintenance and renewal

of rolling stock. At present every line has its own little workshops, with its own patterns of rolling stock, several patterns existing sometimes on one line. When new engines or wagons are required, they are bought, one or two at a time, on very disadvantageous terms of payment. All this should be swept away. Under one large company, or central management, the rolling stock should be standardized, so as to interchange on every line of the same gauge and with larger quantities of engines, carriages, and wagons of standard types, they could be purchased and repaired with much greater economy than obtains at the present time. Were this to be done the financial standing of Irish light railways would assume a very different aspect. As it is, these small lines working under the above-named disadvantages are nevertheless doing extremely good work in developing the resources of districts beyond the reach of ordinary railway communication; and, notwithstanding the baronial rates that are levied in most cases, to supply the deficiency between profits and the guaranteed interest on capital, it is certain that they are popular.

THE BARSI ROLLING STOCK.—LOCOMOTIVES.

26. The principal novelty in the Barsi rolling stock has been the adoption of a uniform working axle-load throughout for engines, wagons, and carriages; the working axle-load being also the maximum adopted for the rail, namely 5 tons. On all other light railways, and indeed I may say on all railways with which I am acquainted, it is customary for the engine axle-loads to be much greater than those in use on the carriage and waggon stock. On the 3 ft. gauge light railways in Ireland, for instance, of which there are now eleven with a total length of 202 miles, the maximum axle-loads on carriage and wagon stock vary from 3 to 4 tons, while the engines have axle-loads of 8 and 9 tons requiring rails of 50 lbs. per yard, or exactly double what would have been necessary if the engine axle-loads had been maintained at a figure approximating to the maximum axle-load of the carriages and wagons. The additional weight on the wheels of these Irish engines was totally unnecessary, as has been proved by the Barsi engines, whose total adhesion and tractive force is greater nothwithstanding their much smaller axle-load. To get the greatest cubic and load capacity out of narrow gauge wagon stock, the maximum axle-load must be utilised to its full extent. We arrive, therefore, at a principle in light railway construction which is that the greatest economy, *i.e.*, the maximum carrying capacity on the minimum weight of rail, can be secured only by uniformity of axle-load.

27. The next point to which I would direct attention is that the whole of the Barsi rolling stock has been constructed on a system of standard details, so that like articles are interchangeable throughout. Each part of the engine has been most carefully designed, not only with reference to its work, but also with regard to its position and the effect of its weight in securing that the maximum axle-load should not be exceeded on any single pair of wheels. Every single detail has been allotted a standard number, which is stamped upon it, so that in case of damage from accident, or in the course of ordinary wear and tear, all damaged parts can be obtained from the head-quarter stores depot, or ordered from England merely by cabling their standard numbers. The same principle of the standardisation of parts has been carried out throughout the carriage and waggon stock. This system is productive of extreme economy, not only in construction, on account of the lessened cost of the manufacture of numbers of identical articles, but also in maintenance, as it allows of the behaviour of parts being kept constantly under observation. In the working of rolling stock designed on these principles, the quantity of any one standard part worn out or repaired each half-year arrives at a figure dependent on the number in use and the train-mileage run. If the number be found to be abnormally high, attention is directed to the subject, and the defect, whether of design or material, is rectified. It will be seen that when once the relationship of repairs and renewals to train-mileage is ascertained, the quantities of all standard duplicates required for renewal in any half-year, or on any given train-mileage, can be estimated for in advance with very great accuracy. In the case of light railways in India and the Colonies, a line has to draw on England as its base of supplies. Consequently, it is most important that the stores can be indented for sufficiently in advance to prevent rolling stock from being incapacitated and withdrawn from traffic because they have not arrived in time. The Barsi rolling stock has been specially designed with reference to its adaptability for military purposes, and I need hardly say how extremely important in military operations it is that repairs should be

effected with the least possible delay. The standard detail system permits of the system of repair *by exchange.* Exchange is a matter of minutes, while repair is a matter of days and weeks. We arrive now at another principle in light railway construction, namely, that the rolling stock should be of the fewest types, and that each of those types should be built up of the greatest number of standard parts.

28. The Barsi engine, built by Messrs. Kitson and Co., of Leeds, a general drawing of which I now put upon the screen, is 29 ft. 6⅛ in. long over buffers, and weighs 29 tons 8 cwt. in working order and fully loaded. It is of the consolidation type, having eight wheels coupled of 2 ft. 6 in. diameter, and is provided with a four-wheeled swing link bogie truck at the trailing end. The cylinders are 13 ft. diameter by 18 ft. stroke. The regular running speed under full loads is 15 miles per hour, but the motion is perfectly balanced, and speeds of from 25 to 30 miles can be attained without difficulty. The working pressure is 150 lbs. The slide valves are balanced and driven by Walschœrts gear, dispensing with eccentrics. The tanks have a capacity of 800 gallons, and the coal bunker of 4 tons. The tractive force of the engine is 11,088 lbs., with a cut off at 75 per cent. of the stroke, 10,650 lb. at 70 per cent., and 9,610 at 60 per cent. The following photograph is of the engine, "Sir Richard Webster," which is now doing very good work in India. The slidebars are boxed in to keep out dust, the engine being built for use on ordinary roads. All the wheels, including those of the bogie, are fitted with brake-blocks operated by hand or steam at will. The engine is fitted with a whistle for train signalling, a siren to warn cattle off the road, and with a steam bell for use when moving through the streets. The total wheelbase is 18 ft. 6 in., but the rigid wheelbase is only 8 ft. 3 in., which enables the engine to run round extremely sharp curves. The engine and all other vehicles are fitted with the Jones-Calthrop Patent Flexible Buffer-Coupling. At the Newlay Exhibition this engine took a train load of 180 tons up a gradient of 1 in 57 occurring on reverse curves averaging 200 ft. radius. The curves as laid down were parabolic, and at the sharpest point were equal to a radius of only 175 ft. During the trials the weather was generally very bad, and the rails greasy, so that the performance which was repeated many times daily was a severe test of the powers of the engine. On several occasions the train was stopped on the reverse curves when mounting the gradient, and was re-started without difficulty. On a level straight line this engine will draw 1,036 tons at 15 miles per hour. On the heaviest gradient and curve on the Barsi main line, namely, 1 in 100 on 600 feet curve, the engine will haul 291 tons at 8 miles per hour. A train of 280 tons, composed of 13 low-side wagons and 1 brake, fully loaded, will have a tare weight of 65 tons 7 cwt., and will carry 210 tons of goods. As 16 trains a day can be run in each direction without difficulty, the theoretical capacity of a single line with crossing stations is no less than 3,360 tons each way, which is several times what is required even in the height of the busy season.

My photographs are as follows:—Engine "Hamilton" at the Newlay Exhibition; plan and section of line at Newlay Exhibition; view of the S curve; ditto with train; ditto with train; side view of the train on curve; side view of the train on straight; train ascending gradient; rear view of the engine.

29. While these photographs are fresh in your minds, I put on the screen views of the rolling stock now in use on other narrow gauge lines in India:—The first is a view of an engine and train on the Darjiling-Himalayan 2 feet gauge railway. The wagons and carriages are all four-wheeled, and are about 12 feet long. The second is a four-wheeled coupled tender engine on the Morvi 2 ft. 6 in. gauge railway, capable of taking a train of 80 tons. The third is a four-wheeled coupled tank engine on the Kannia-Jatrapur 2 ft. 6 in. gauge line, which takes a rather larger load on a perfectly flat line without gradients. The fourth is an illustration of the types of carriages and wagon stock on this line. The fifth and sixth are views of trains on the Shah-Jehanpur 2 ft. 6 in. gauge steam tramway.

Although the above examples of the rolling stock now in use in India are all of much smaller capacity than the Barsi type, yet they have done really good work, as is demonstrated by the average return on capital amounting, as has been shown, to nearly 8 per cent.

30. You will have observed that the engine is fitted with a central buffer which also forms a coupling. This buffer coupling which I now place upon the screen is a modified form of the Jones Patent Flexible Buffer, adopted as the standard for metre gauge lines by the Government of India, to which I have added rocking dishes which permit it to move laterally through an angle of 36°. The two buffer heads are coupled by means of the central

hook, and are drawn together by a right and left hand screw coupling, so that the buffer spindles become practically one solid bar. There is, therefore, no movement or slack whatever between the two heads. When a train is going ahead the two outer springs are in compression: in shunting the two inner springs are compressed. The buffer spindles are not at any time in rubbing contact with any part of the headstock, being supported only at the smaller ends of the springs, and, as there is no rubbing of the heads, the wear and tear of the buffer is practically *nil*. It will be seen that this Jones-Calthrop buffer is what is technically termed a tight coupling, and, as there is no slack between the heads, it is impossible to cause damage by snatching, which is an important feature, since my experience of wagon repairs shows that 90 per cent. of the withdrawals of wagons from traffic are due to damages to draw-gear caused by snatching slack couplings when starting a train, or in taking up the slack at the bottom of inclines. The large angle, through which the rocking dishes permit the buffer to move, has enabled me to put cars 40 ft. long on this narrow gauge. The principal advantage of the buffer, however, is derived by the great freedom of the lateral movement, by means of which flange friction round sharp curves has been reduced to such an extent as to very appreciably increase the train load. I have no doubt that the large excess which our engine at Newlay drew over its theoretical load, calculated on the usual formulæ, was due in part to the reduction, as explained above, of resistances on sharp curves.

The succeeding photographs show:—(*a*) View of buffer between two 40 ft. coaches on curve of 175 ft. radius showing angle made with headstocks; (*b*) plan of buffer showing maximum angle of lateral movement.

THE BARSI ROLLING STOCK.—WAGONS.

31. I now come to a description of the tare weights of the Barsi wagon stock, which have been designed to combine the greatest carrying capacity with the minimum tare weight, and which, together with the great power of the engines, formed the chief point of attraction at the Newlay Exhibition. It has been explained that in designing the permanent way and rolling stock for a narrow gauge light railway the principal object to be aimed at is to obtain the greatest proportionate traffic capacity from the cheapest possible track. With a given engine power, any reduction in the dead weight of the train produces a corresponding increase in its carrying capacity, and our object at Barsi with our large traffic has been to carry the heaviest goods load per train, on the the lightest tare weight compatible with a proper reserve of strength, and a due regard to the cost of maintenance and repairs. After careful examination of various systems claiming to effect reductions in the tare weights of rolling stock, I ultimately selected that known as Fox's Pressed Steel Underframes. By the adoption of pressed steel, I have been able, while working to the uniform maximum axle-load of 5 tons, to design open wagons, 25 ft. long over headstocks, with a paying load of 15 tons 18 cwt., and a tare weight of only 4 tons 2 cwt. the per-centage of tare to the total being only 20·5 per cent. This low-side wagon was placed under a test load of 40 tons of pig-iron with a temporary deflection of five-sixteenths of an inch between bogie centres, and without a trace of any permanent set. A second wagon was placed under the same load of pig-iron at the Newlay Exhibition with the same deflection, where it remained for a week, and when unloaded there was again no trace of permanent set. By way of contrast, I show our competitor the bullock-cart, with its half-ton load. Over 30 bullock carts would be required to carry the working load of this one wagon, of which we can take 13 in one train. The next photograph shows the underframe of this low-side wagon reversed. The high-side open wagons weigh 5 tons 7 cwt. and carry 14 tons 13 cwt. of goods. The covered wagons weigh 5 tons 18 cwt. and carry 14 tons 2 cwt. While I do not deny that other systems have their merits, I know of none other which can produce such results as these while maintaining simplicity of detail and the same reserve of strength.

32. Light tare weight effects a permanent economy in working expenses by making it possible to carry a greater quantity of goods per train at the same cost of coal, oil, and wages, and by reducing the wear and tear on permanent way. This is an actual saving of revenue, day by day, and year by year, in respect of every train that is run. In regard to capital cost, the results are of the highest possible importance. Had our wagon stock been built with the usual heavy tare weights it would have been necessary, in order to carry the same weight of goods in each train, to have adopted a greater axle-load, to have designed much heavier and more powerful engines, and to have employed rails and permanent way of much greater weight per yard.

To secure these advantages it would be

worth while, if it were necessary, to pay more per vehicle for wagon stock. I want, however, to point out that although the cost of pressed steel, the "tubular," or any other system for effecting large reductions in tare weight, is undoubtedly greater per ton weight of the vehicle, it is actually less per ton weight of the load. The design and carrying capacity of a vehicle is the proper basis on which to compare the relative cost of wagons. In purchasing wagons of a heavy tare you actually pay more for what you want to get rid of. I am, of course, comparing the cost of pressed steel with wagons of ordinary construction, which have been designed and built to give good results in working and maintenance, and not with some light railway stock with which I am acquainted, which is built only to sell.

33. The wagon stock for all classes of work is of the bogie type, 25 feet long over headstocks and 7 feet wide. The length over buffers of each vehicle is 28 ft. 3 in. The centres of the bogies are 16 ft. 8 in., and the wheelbase 4 ft. 5 in. The weight complete on rails of each wagon fully loaded is 20 tons, or 5 tons per axle. The bogies of both carriage and wagon stock are of the swinging bolster type, and are identical and interchangeable. A few wagons have been fitted with bogies without the swinging bolster, for experimental purposes, but these bogies are interchangeable with the remainder. The next slide is from a photograph of the swinging bolster bogie, which is followed by a drawing. The second drawing shows the non-bolster bogie.

34. The Timmis system of springs has been adopted throughout the carriage and wagon stock with much success in obtaining smooth running. The system consists in the use of duplex spiral springs, so arranged that when the vehicle is running empty, one spring only of each set is in action; but when running loaded, both are called into play. This is a point of considerable importance for very light stock, since, in the absence of this arrangement, a wagon, when unloaded, would run virtually without springs, and so be subjected to unnecessary vibration, which means useless wear and tear.

35. The next slide shows a low-side wagon loaded with sacks. The first layer of sacks are placed with their ends lying upon the low side. This gives them an upward tilt, which is communicated through each of the succeeding layers up to the top, so that bags and socks loaded in this way cannot fall off. This wagon has sufficient capacity to carry full loads (15 ton 18 cwt.) of wheat, seeds, and pressed cotton, and is the best for general utility. The low side facilitates loading and unloading. It will be seen that the ends of this wagon are stamped from one plate. The brake acts on both wheels of one bogie, and can be operated from either side of the wagon. This wagon weighs 4 ton 2 cwt., and carries 15 ton 18 cwt.

36. The next photograph shows a high-side wagon loaded with coal. It is fitted both with side and end doors—the latter to enable guns and limbers to be carried. Owing to the end doors and their brackets, a wheel and chain has been substituted for the end brake lever. This gear can also be operated from either side. The sides of these wagons are stamped and dished in sections. The dishing should be sufficient to deflect a bullet, while the flanges prevent splashing. This wagon weighs 5 ton 7 cwt., and carries 14 ton 13 cwt.

37. The next slide shows the covered wagon also built entirely of steel. It weighs 5 ton 18 cwt., and carries a load of 14 ton 2 cwt. Its capacity is 1,000 cubic feet. The body is 7 feet wide and 6 ft. 6 in. high inside, and is designed to carry six horses, with forage and attendants, and, at a pinch, it can carry nine.

THE BARSI ROLLING STOCK.—CARRIAGES.

38. The carriage stock for all classes of work is also of one length, namely 40 ft. 6 in. over bodies, and 40 feet over headstocks. The bodies are 7 ft. 6 in. wide over sunshades, and 6 ft. 2 in. between standing pillars. The underframes for every class of vehicle, one of which I now show, are identical in every respect, and interchangeable. The bogies are 28 feet centres, with a wheelbase of 4 ft. 3 in., and, as stated, are interchangeable with those under the wagons. The cars for ordinary use are built to weigh, with a double complement of passengers and baggage, rather less than 20 tons on rails, which is equal to 5 tons per axle. They are capable of taking curves of 150 feet radius. The cars are supplied with gas fittings throughout. There are only two classes, namely, upper and lower class, but the lower-class compartments are of a style and finish equal to that usual in the second class. We believe in catering for the comfort of our lower, or third-class passengers from whom we shall derive a large revenue.

A passenger train made up of one upper-class car, eleven lower-class cars, and one compound brake van, allows full seat room for

30 upper-class and 736 lower-class passengers. In times of pilgrimages, or on other special occasions, 1,000 passengers could be carried in a single train.

39. The next two slides show the special saloon car, which contains a main saloon, a smoking or inspection compartment at the end, an extrance and luggage vestibule, a lavatory with a bath and wash basin supplied with hot water, a kitchen and servants' compartment. The latter communicate with the entrance vestibule by means of a side corridor. The car has sleeping accommodation for six passengers. These, and all other cars, have sunshades and double roofs, glass lights, louvre shutters, and venetian ventilators. This car weighs 12 tons 13 cwt., all complete. The next view is of the interior of the general saloon, which proves, I think, that narrow gauge is not incompatible with comfort or even luxury in travelling. The bodies of all the cars were built by the Lancaster Railway Carriage and Wagon Company.

40. The compound brake vans, one of which I now show, have been built with upper and lower-class compartments to enable passengers to be carried by every goods train. The upper-class compartment has seats for six passengers and sleeping berths for four, and is furnished with lavatory accommodation. The lower-class compartments are fitted with cross seats, and carry 32 passengers. The brake vans weigh 12 tons 1 cwt. each. The next slide shows the interior of the lower-class compartments. The cross seats carry four passengers each comfortably, and, at a pinch, five.

41. The lower class cars have lower class compartments and carry 64 passengers. I put one on the screen. They weigh 11 tons 13 cwt.

MEANS FOR AVOIDING TRANSHIPMENT AT JUNCTIONS BETWEEN BROAD AND NARROW GAUGE RAILWAYS.

42. The value of narrow gauge in reducing cost is so great, that any practical proposal which promises to avoid the cost, loss of time, and damages to goods caused by transhipment, and yet permit the use of narrow gauge for short branch lines, will, in view of the light railway projects now being matured in England, at all events be regarded with interest. I propose to effect this by means of transportation cars and transfer bogies; the former being intended for general use in England and the latter to meet special conditions in India and abroad.

43. The first illustration shows a standard gauge wagon, from which its own wheels have been removed and replaced by narrow gauge transfer bogies carrying bolsters, furnished with dummy axle-boxes, so that the wagon is carried on its own springs. The transfer bogies, however, are not suitable for light railways in England where the average length of line is so short, but have been devised for a special purpose, namely, with the object of carrying standard gauge wagons loaded with coal, which suffers much in transshipment over long lengths of metre gauge line, amounting in the case of the Southern Mahratta Railway to hundreds of miles. These coal wagons would come back to the junction and to their own wheels and axle-boxes, and the short time occupied in the exchange, effected by means of an hydraulic lifting plant, would be justifiable and economical.

44. The following four photographs are of an experimental four-wheeled transportation car tested at the Newlay Exhibition. It was constructed to demonstrate the feasibility of carrying by this means loaded lurrys from Liverpool to Manchester on a narrow gauge line so as to avoid all transhipment between ships' side at the Liverpool docks and the warehouse in Manchester and *vice versâ*. This project is now under the consideration of a special committee of the Liverpool Chamber of Commerce appointed to investigate means for transporting traffic in competition with unduly heavy rail charges. The result was a successful demonstration of the stability of the cars and of the feasibility of the project as far as these mechanical proposals were concerned. The next photograph shows the transportation car specially designed for this work, and capable of carrying two lurrys with loads of 8 tons each.

I may point out that the carriage of road vehicles on a plateway, or by means of narrow gauge bogies secured to their axletrees is not a practicable operation, when it is intended to haul them in trains by locomotives. If the bodies are built strong enough to withstand train strains, then they become too heavy for haulage by horses on roads. If they are not built to withstand train strains their speedy destruction is inevitable.

45. The next illustration is a drawing showing a transportation car carrying a 4 ft. 8½ in. gauge wagon on a 2 ft. 6 in. gauge line. It will be seen that nothing further is required at the junction but to run the standard gauge wagon on to the transportation car at a dead end siding, the rails of which are on a level with the rails attached to the troughs

of the transportion car. The transfer can be effected in about three minutes, all that is necessary being to secure the wagon on the car by means of suitable shoe-clips, or, when on a level line, merely by applying its own brake.

Several projected light railways in England already propose to make use of this system, and I hope before long to see it tested also in India.

46. The following illustrations show the use that can be made of a transportation car, to carry a 12-pounder field gun, with limber attached, or two commissariat wagons, is that they can be entrained or detrained instantly on any part of the line.

IS A GUARANTEE OF INTEREST NECESSARY FOR A LIGHT RAILWAY IN INDIA?

47. As the Barsi Light Railway is itself an instance of the possibility of raising capital in England for such a purpose without any guarantee of interest, and upon the prospects of traffic alone, it is one of my objects in appearing before you this evening to suggest that the reducing of capital expenditure to the extremely low figure per mile represented by the cost of a 2 ft. 6 in. gauge railway is in itself a sufficient guarantee, as regards projects sanctioned by the Government of Iudia, that the return on capital cannot be otherwise than satisfactory. It has been demonstrated that when a line can be built at a very low capital cost per mile it will pay to run through country of a very poor character. In the case of Barsi, the traffic was already of large proportions, and was known to be sufficient to produce a handsome return on the capital required, without taking into account the expansion which invariably follows on the introduction of lower charges and greater facilities, consequently the character of the security was such that an application for a guarantee of interest became distinctly unreasonable—and therefore none was made.

48. Of course each individual project must be dealt with in accordance with its own merits and circumstances; but there are to my own knowledge many localities in India, where the prospects of traffic are extremely good, and in which light railways could be constructed with the perfect assurance of their financial success. Records of the traffic passing over main roads in India are always available, and when returns are as reliable and complete as they were in the case of Barsi, the necessity for receiving a guarantee of interest, before capital could be raised in London, should become much less pressing. That the existing 2 ft. 6 in. gauge railways can produce an average return of nearly 8 per cent. on their capital, even when working under the disadvantages, as most of them are, of unfavourable localities, short leads, and of diminutive rolling stock, I have already shown. That the time is now approaching when such results must arrest the attention of the British investor I am fully persuaded. When the still better results, which will be given by 2 ft. 6 in. gauge lines of greater length and provided with rolling stock of the capacity shown you this evening, are made manifest, it must be generally recognised that capital can be safely invested in such enterprises without seeking the further protection of the Secretary of State, who, I need not say, demands a not unreasonable *quid pro quo* for the service. A guarantee of 3 per cent. on capital undoubtedly would render the financing of light railways in India a very simple task, since it enlarges the field from which capital can be drawn, and the smaller capital required per mile would render the risk of such a guarantee being claimed extremely remote as compared with the risk attaching to a line of standard gauge; but, on the other hand, if it can be as clearly established, as in the case of Barsi, that a projected line must return a considerably greater per-centage than the 3 per cent. guaranteed, it seems not unreasonable to anticipate that investors should prefer to retain for themselves their excess profits, amounting to, perhaps, 5 or 6 per cent. annually, instead of making over the half of them to the Secretary of State, to avoid a risk which can be proved to be practically non-existent. When this time comes—as come it most surely will—I look forward to an immense development of railway enterprise in India on this system of light railways, which will have not only a very welcome effect upon the fortunes of the standard gauge trunk lines, served by such feeders and distributers, but will bring into intimate contact with ourselves and our manufactures all the millions in the great areas untouched and unaffected by the present railways, who are not yet, or are only to a very limited extent, consumers of the products of British labour.

49. In the great calamity of famine now affecting India, which history shows to be inevitably recurrent, when from emaciation and death of cattle the present means of transport is apt to break down totally, so that, in many cases, it has been literally impossible to get the grain standing at railway stations

to the people dying for want of it, there is no safety but in the shadow of the iron horse. For £15,000,000—the cost of the Manchester Ship Canal—8,000 miles of 2 ft. 6 in. gauge railways might have been built in India and provided with rolling stock. It is impossible not to reflect that, while such an extension of the Indian railway system would have been of priceless service in saving thousands of lives at the present juncture, not only Manchester itself, but the whole of England, would have been deriving infinitely grater benefit had such a sum been so applied.

I have been requested to add a few remarks on

THE BARSI ROLLING STOCK AS APPLICABLE TO MILITARY OPERATIONS.

50. The theoretical requirements of a field railway, which I state with the diffidence which becomes a mere civilian, appear to me to be that, *generally* the equipment must include permanent way, portable bridges, rolling stock, and all stores of whatever kind that may be required in any part of the world for use on an unsurveyed route through a country unprovided with railways, and so as to be entirely independent of local resources, and, *in particular*, as follows:—

(1) The permanent way to be portable and of a pattern which takes the fewest men to handle and the shortest time to put together, and to be of the least weight and bulk compatible with the largest traffic capacity.

(2) The rolling stock to have a uniform maximum axle-load and to have the greatest load capacity with the lightest tare weight, compatible with a proper reserve of strength.

(3) The wagon stock, while adapted to the greatest number of purposes and contingencies, to be of the fewest types. Details as far as possible to be common to and interchangeable in all types, and so that repairs in the field can be effected by the exchange of standard parts.

(4) The rolling stock to be of such patterns that their erection on arrival should be an expeditious operation requiring neither tools nor workshops.

51. I wish to point out briefly to what extent the Barsi rolling stock fulfils these conditions.

As regards No. 1 both rails and sleepers stow perfectly for shipment. A 24 ft. length of permanent way, including ten steel sleepers, can be put together in situ, keyed and fished by six men in about five minutes, when working systematically. The permanent way can also be carried in the wagons put together with sleepers complete in 24 ft. lengths ready for laying down. The weight of permanent way with 30 lb. rails and 40 lb. sleepers, with the usual additions for contingencies and waste, is 90 tons 16 cwt. per mile. The net load of stores which can be taken on a gradient of 1 in 100 is 210 tons, so that with 13 low-side wagons and one brake a single train can carry two miles of track per trip with a full complement of workmen. The Barsi rolling stock can transport in either direction a maximum of 3,360 tons daily over a section 20 miles long with a ruling gradient of 1 in 100, and a maximum of 1,680 tons with gradients of 1 in 50 on curves of 250 ft. radius. This is on a basis of 16 trains a day in either direction, which, with crossings, can be worked without difficulty. As regards troops, a battalion with stores and impedimenta could be carried in one train over grades of 1 in 100 and a half-battalion over grades of 1 in 50.

As regards No. 2 that the rolling stock shall have a uniform maximum axle-load and the greatest load capacity with the lightest tare weight compatible with a proper reserve of strength, the Barsi rolling stock represents I believe, an advance on anything which has been done hitherto, in these directions, as regards light railways. The wagons are so light that they reduce the weight and bulk of permanent way to the smallest proportions, thereby increasing the length of track which can be carried in one ship, or by one train, and the permanent way being lighter it is more easily handled and laid quicker.

52. As regards No. 3 the Barsi wagon stock has been restricted to three types, which are all that are necessary for ordinary traffic purposes. The parts which are subject to wear and tear are identical and interchangeable throughout.

53. With reference to No. 4 that the rolling stock should be of such patterns that their erection should be an expeditious operation requiring neither tools nor workshops, the whole of the rolling stock has been erected in India under these conditions. The pressed steel underframes require no trusses, and very little packing, consequently they stow closely on board ship and the risk of breakdown from lost truss-bolts and nuts is avoided. Their lightness enables them to be shipped in large pieces, and to be handled with very elementary lifting appliances, so that the time lost on arrival, in erecting stock shipped in small sections for the greater convenience of hand-

ling is avoided. The following slides show how little packing is required for the carriage and wagon underframes when despatched for shipment.

The first photograph shows a load of wagon underframes all 25 ft. long.

The second shows a load of carriage underframes 40 ft. long.

The third a train-load of car and wagon underframes.

As regards landing carriage and waggon stock from vessels, the underframes can be lowered forthwith on to the bogies, which can be shipped complete with wheels, direct from the ship's side, and the cases containing sides and ends can then be lowered on to these underframes as they stand. The underframes as soon they are on their bogies already form a moveable wagon and can be rolled away to sidings where their erection will be completed. One engine could be carried erected complete on deck and slung down on to rails or run down an inclined plane, so as to be ready for the first lot of wagons when put together. It is of the greatest importance to keep the landing clear of accumulations of stores.

As regards the erection of carriage stock I exhibit photographs of the manner in which the Barsi cars are shipped. The first photograph shows a brake van complete before being taken to pieces. The second shows the roof lifted off in one piece; the sides and partitions taken apart in single pieces; and the floor in one piece, placed in the packing case, into which the roof will be lowered. The second photo shows the roof lowered on the floor into the packing case. The partitions are packed in a square case by themselves, and the two sides complete with doors and sunshades in one long case by themselves. With the proper lifting appliances these cars can be put together in running order on rails in four or five days from the time of unpacking the cases. Military carriage stock would be of the same length but of a simpler character, and could be put together in a few hours.

The object of this system is to leave the parts as complete as possible so that the work of erection on arrival is made as simple and expeditious as possible. For expeditious work I do not believe in the system of designing rolling stock for military purposes out of permanent way material, with small units which can be converted into larger units and so on. The whole thing becomes a large Chinese puzzle, and unless you have men who are thoroughly acquainted with all the parts and their combinations, the result is too often a big muddle. What is wanted is the fewest number of parts, and extreme simplicity throughout, so that it is perfectly obvious to an ordinary mechanic where everything has to go, without requiring either drawings or instructions.

54. To be of the fullest use, a military railway must keep abreast of the advance of the troops, which means progress at an average rate of ten miles a day. I regard this as a practicable aim provided the work of construction proceeds with a maximum speed and efficiency from the first day and hour of debarkation. Twenty miles lost, by avoidable delay at the start, may never be made up. It is only continued practice that can ensure the smart start off. No railway corps can make a proper show on service, unless all the operations of disembarkment, erection, alignment and construction are as familiar as are the ordinary evolutions on the parade ground. Once this familiarity is attained under conditions approximating to those existing on active service, I see no reason why a light railway could not be laid down at a speed much greater than that which has as yet been attained in the field.

DISCUSSION.

The CHAIRMAN said that, as an old member of the Society, and as having presided at a great many of its meetings, he could not remember any paper which was more thoroughly entitled to excite full interest and to receive discussion, or one which was more admirably thought out in all its details, than that which had just been read. The amount of matter it contained was certainly astonishing, and Mr. Calthrop deserved thanks for thus putting before the scientific and commercial world the capabilities of light railways. When it was stated that on these railways a wagon would take a load of 15 tons 18 cwt. with a tare weight of only 4 tons 2 cwt., it was astonishing that their capabilities had so long remained undiscovered and undeveloped. And this was a matter that ought to be brought prominently before the attention of those who were considering the light railway problem in England as well as in India. There were several points in which the rolling stock described in the paper appeared to meet several requirements which were ordinarily lost sight of, and yet of great importance from the point of view of economy in construction and transport. For instance, Mr. Calthrop described a most ingenious arrangement for packing together the various portions required for the line, so that they might be readily used when required for repairs or removals. The striking thing about this paper was that it did not seem to be merely the application of one clever invention or improvement, but the careful thinking out of a whole system, whereby we had first the lightening and cheapening of the permanent way without loss of efficiency, and then fitted to that and suited to its special needs a standard rolling stock, and the very remarkable improvement—which was lost sight of entirely in the case of the Irish railways —of having the same weight on the axle load of the engines as on the axle load of the trucks. He was struck with the capabilities which this class of rolling stock and this class of line afford for running round very sharp curves and for surmounting very steep gradients. It was quite clear, from the information given in the paper, that there was an enormous future for the development of the commerce and trade of India, if only we pursued the reasonable policy of projecting and supporting feeder lines like the Barsi Railway, instead of letting the country remain with methods of locomotion and transport centuries old. One of the most interesting portions of the paper was Mr. Calthrop's description of his own invention of the Transportation car. There seemed no reason why an ordinary lorrie or railway wagon should not be taken straight from the broad to the narrow gauge lines by this method, effecting an enormous saving in the avoidance of transhipment, detention or detraining. One of the reasons for the comparative failure, commercially, of Irish light railways was, no doubt, that there had been a very heavy standard of construction insisted upon, and that, in several instances, a larger gauge than was necessary had been adopted. In regard to the English light railway proposals, now being considered by the Commissioners appointed under the recent Act, one of the main difficulties was that most of the lines would have to be worked by the great main lines, and, as Mr. Calthrop said, engineers and traffic managers, and others who had been brought up in the school of our magnificent, solidly-made, heavy lines, could not readily bring themselves to believe that so much good was to be got of these light railways. Perhaps Mr. Calthrop would, in replying, state what his view was as to the speed practicable on these lines for goods and passenger traffic. In conclusion, the Chairman said the Society were greatly indebted to Mr. Calthrop for a paper full of useful matter for discussion, and affording an immense amount of information to those who were now studying this most interesting problem.

Mr. W. R. S. **Jones** remarked that, full as the paper was, it contained no reference to the important matter of the cost of these railways. In considering this problem, we must ask whether there would be an adequate return upon the capital required; he did not mean on the share capital or stock representing the cost of original construction, but the question was what proportion the cost of working bore to the receipts earned. He believed that the capacity of light railways was, as yet, scarcely guessed at.

Sir **Owen Tudor Burne**, G.C.I.E., K.C.S.I., congratulated Mr. Calthrop on having at last, in the construction of the Barsi Railway, brought to a successful issue the labour of many years. Twenty-seven years ago, he (Sir Owen Burne) was brought into close association with Lord Mayo, then Viceroy of India, who held precisely the views expressed by Mr. Calthrop in this paper. One of Lord Mayo's great difficulties in giving effect to his views was to persuade engineers not to base their reputation on expensvie bridges and works, but rather on cheap lines; and another difficulty was, the battle of the gauges, the lighter gauges being resisted alike by engineers and military men and merchants. If Lord Mayo were now alive and could have heard about Mr. Calthrop's ingenious transportation car, it would have given him sincere satisfaction. Speaking from his experience of India, he (Sir Owen Burne) believed the railways so lucidly described in the paper would be of very great value in the development of the commerce of that country. It was a poor country, and could not afford to pay for expensive railways, and the greatest blessing that could be given it would be the extension in many districts of light railways like the Barsi line.

Mr. W. **Dean** said this subject was not altogether a new one, whether we referred to the 4 ft. 8½ in. gauge, constructed to carry only limited loads at limited speeds, or went back to that extremely interesting line constructed between 1830 and 1840, from Portmadoc to Blaenau Festiniog, with a gauge of 1 ft. 11½ in. The late Mr. Spooner devoted a great part of his life to developing the capacity of that line, and with a considerable amount of success, but he had expressed the belief that if his gauge had been 2 ft. 6 in. or 2 ft. 9 in., it would have enabled him to do much more satisfactory work. Undoubtedly, a short lead meant an expensive line to work, and that would probably be found a great drawback by some of the lines now sought to be constructed under the recent Act, the average length of which was 12 or 13 miles. The condition of things was altogether different in India, where new districts could be opened up of considerable length by lines of the light character suggested in this paper; and, of course, the circumstance that the smallness of the gauge enabled such lines to be constructed alongside existing highways, must be extremely favourable in reducing the cost of their construction.

Mr. E. **Benedict** said that he had had 22 years experience of railways in India, and congratulated Mr. Calthrop on the successful result of his years of effort in the matter of the Barsi line. As one who had worked on the broad gauge under Brunel, as well as in India, it was rather a shock to his feelings to have to come down to 2 ft. 6 in., but, circumstances alter cases; no doubt, if the broad gauge people had been allowed to make their carriages three times the width of the gauge, they migq have carried more in the same length of train. But it did not follow that the narrow gauge was not, in certain districts, the right thing, especially on the roads; going across country was a different thing. One thing the advocates of light railways must remember was, that, although they were able by their system to follow the features of the country, this necessitated often an increased length of line, and that was an important matter to be taken into consideration. He just mentioned that as the last struggle on the part of a broad gauge man.

Lieut. E. H. M. LEGGETT, R.E., said there was not room for argument as to the tremendous importance of narrow gauge lines from the military point of view. Having regard to the speed with which they could be constructed and the large capacity produced by a small amount of engineering work, such lines must perform very important services in time of war. This was recognised on the Continent, and the amount of money there spent in laying up material was surprising. And the military manuals of the Continental armies dwelt on the uses to be made of these lines in the event of war; in fact the route to be followed had in some cases been worked out. It was well known to the military student that, two years before the outbreak of the Franco-German war, the country round Metz had been surveyed and the route of a railway had been worked out, and, when the city was beleagured, the line as previously arranged was built round Metz, and it supplied the whole of the army before Paris for a considerable number of months. Mr. Calthrop in a recent lecture before the Corps of Royal Engineers at Chatham, set forth three great advantages of light railways from the Service point of view. (1) Portability; this was a most important point, when it was remembered that the line would have to be constructed almost at the same speed as that at which the army were advancing. (2) Capacity for supplying a large number of troops with a minimum number of wagons and engine power. (3) The standardising of the parts; this was an absolute necessity for railways built primarily for military uses. Then, the feature of the carriage of guns and stores was most important. Mr. Calthrop showed that a gun and limber, coupled up, could be carried on a single truck; that was not possible on all the broad gauge trucks, certainly not those of the short pattern adopted in this country. It was no secret that the gauge for military purposes must be a narrow one, and we had adopted the 2 ft. 6 in. In France and Germany they had adopted the 1 ft. 11½ in., the same as the Festiniog Railway; but as we have the 2 ft. 6 in. gauge, there was obviously an enormous advantage in having a certain stock in the country of wagons and carriages which would be available in time of war for our military purposes at the shortest possible notice.

Mr. CALTHROP, replying upon the discussion, said he regarded Mr. Jones as being really the first authority on rolling stock of light tare weight, and there was no one to whom he was more indebted in this matter. With regard to the speed of the Barsi engines for goods and passenger trains, they were limited by the Government of India to a speed of 15 miles an hour while running along an existing road, but, before the line was publicly opened, trains had been run on it at about 30 miles an hour; that speed could be attained if necessary. As to cost, the paper stated at the commencement that the average cost of the 2 ft. 6 in. gauge was 32,000 rupees; that worked out at a little over £2,000 per mile; the cost of the metre gauge worked out at over £4,500 a mile, and that of the standard gauge at about £10,000 a mile. That was the average for all railways in India and under all circumstances, and it included rolling stock, rails, permanent way, and stations and everything. Mr. Calthrop expressed his gratification at the way the paper had been received.

A hearty vote of thanks having been accorded to Mr. Calthrop, the meeting terminated.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

FEBRUARY 24. — "Reproduction of Colour by Photographic Methods." By SIR HENRY TRUEMAN WOOD, M.A. CAPTAIN ABNEY, C.B., F.R.S., will preside.

MARCH 3.—"English Orchards."—By GEORGE GORDON. W. T. THISELTON DYER, C.M.G., F.R.S., Director of Kew Gardens, will preside.

MARCH 10.—"The Prevention of Fires due to the Leakage of Electricity." By FREDERICK BATHURST. W. H. PREECE, C.B., F.R.S., will preside.

MARCH 17.—"Music in England at the Queen's Accession." By J. SPENCER CURWEN. SIR WM. CLEAVER FRANCIS ROBINSON, G.C.M.G., will preside.

MARCH 24.—"The Transmission of Power by Alternating Electric Currents." By W. B. ESSON, M.Inst.C.E.

MARCH 31.—"Cycling—Historical and Practical." By GEORGE LACY HILLIER.

APRIL 7.—"Dairy Produce and Milk Supply." By M. J. DUNSTAN, M.A., F.R.S.E.

Papers for evenings, the dates of which cannot yet be announced:—

"London Water Supply." By PERCY F. FRANKLAND, Ph.D., F.R.S.

"The Evolution of the Silver Question." By MORETON FREWEN, B.A.

"Children's Sight." By R. BRUDENELL CARTER, F.R.C.S.

"Fireproof Construction." By THOMAS POTTER.

"Motor Traffic: Technical Considerations." By Sir DAVID SALOMONS, Bart.

INDIAN SECTION.

MARCH 11, at 4.30 p.m.—"Prevention of Famine in India." By SIR CHARLES ALFRED ELLIOTT, K.C.S.I. (Secretary to the Famine Commission of 1878, and late Lieutenant-Governor of Bengal). The Rt. Hon. LORD GEORGE HAMILTON, M.P., Secretary of State for India, will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock :—

MARCH 16.—"The Progress of the British Colonies of Australasia during the Sixty Years of Her Majesty's Reign." By JAMES BONWICK.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock :—

MARCH 2.—"Gesso." By MATTHEW WEBB.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

C. F. CROSS, "The Industrial Uses of Cellulose." Three Lectures.

FEBRUARY 22.—LECTURE II.—Paper-making (continued)—Recent progress in methods—The theory and practice of paper-sizing—Sizing with soluble cellulose compounds—(*b*) Textiles—Progress in chemical methods, in spinning (flax), and in yarn and cloth bleaching (cotton, linen, jute)—Mather-Kier system—Present position of rhea industry—Novel applications of mercerising process—Production of crêpons by printing: alkali and acid processes—Finishing processes and new applications of cellulose compounds.

HOWARD LECTURES.

Thursday Evenings, at Eight o'clock :—

PROF. JAMES A. EWING, M.A., F.R.S., "The Mechanical Production of Cold." Six Lectures.

FEBRUARY 25.—LECTURE V.—Tests of performance of refrigerating plant—Trials by the Munich Commission and others—Industrial applications—Cold storage and transport—Cooling of air and liquids—Ice making: ice rinks—Distribution of cold from central stations.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 22 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. C. F. Cross, "The Industrial Uses of Cellulose." (Lecture II.)

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. A. Wynter Blyth, "The Laws Relating to the Supervision of Food Supply."

Imperial Institute, South Kensington, S.W., 8½ p.m. Mr. C. A. Barber, "The Past, Present and Future Sugar Supply of the British Empire."

Surveyors, 12, Great George-street, S.W., 8 p.m. 1. Adjourned Discussion on Mr. J. Willis Bund's Paper, "Allotments and Small Holdings." 2. Mr. C. H. Hooper, "Fruit Growing as an Auxiliary to Agriculture."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Actuaries, Staples-inn-hall, Holborn, E.C., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. E. T. Garwood, "Spitzbergen."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. W. E. Henley, "Robert Burns."

TUESDAY, FEB. 23...Royal Institution, Albemarle-street, W., 3 p.m., Professor A. D. Walker, "Animal Electricity." (Lecture VI.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Photographic, 12, Hanover-square, W., 8 p.m. 1. Mr. Thomas R. Dallmeyer, "The *f*/6 Stigmatic Lens and the New Astigmatic Corrector." 2. Mr. F. E. Ives, "The Perfected Krōmskōp."

Anthropological, 3, Hanover-square, W., 8½ p.m.

WEDNESDAY, FEB. 24...SOCIETY OF ARTS, John-street, Adelphi, S.W., 8 p.m. Sir Henry Trueman Wood, "Reproduction of Colour by Photographic Methods."

Geological, Burlington-house, W., 8 p.m. 1. Miss Catherine A. Raisin, "The Nature and Origin of the Rauenthal Serpentine." 2. Mr. W. P. D. Stebbing, "Two Boulders of Granite from the Middle Chalk of Betchworth (Surrey)." 3. Mr. W. S. Gresley, "Coal—a New Explanation of its Formation, or the Phenomena of a New Fossil Plant considered with reference to the Origin, Composition, and Formation of Coal Beds."

Royal Society of Literature, 20, Hanover-square, W., 1 p.m.

British Astronomical, University College, Gower-street, W.C., 5 p.m.

THURSDAY, FEB. 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Howard Lectures.) Professor James A. Ewing, "The Mechanical Production of Cold." (Lecture V.)

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. R. Kearton, "Peeps into Nature's Secrets."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. George C. Haité, "Design and Designers during Her Majesty's Reign."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. A. Wynter Blyth, "Sanitary Laws and Regulations Governing the Metropolis."

Royal Institution, Albemarle-street, W., 3 p.m., Dr. J. W. Gregory, "The Problems of Arctic Geology." (Lecture III.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. F. T. Hollins, "Electric Interlocking the Block and Mechanical Signals on Railways." 2. Mr. E. Wilson, "Relative Size, Weight, and Price of Dynamo Electric Machines."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. H. Jones, "Silchester: the Result of Recent Explorations."

FRIDAY, FEB. 26...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Colonel C. R. Conder, "Palestine Exploration."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. Mr. J. H. Vincent, "The Photography of Ripples."

SATURDAY, FEB. 27 ... Royal Institution, Albemarle-street, 3 p.m. Mr. W. F. Lord, "The Growth of the Mediterranean Route to the East." (Lecture III.)

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FRIDAY, FEBRUARY 26, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

REPRODUCTION OF COLOUR BY PHOTOGRAPHIC METHODS.

The specimens used to illustrate Sir Henry Trueman Wood's paper on the "Reproduction of Colour by Photographic Methods" will remain on view until Saturday, 27th inst., and the exhibition will be closed on that day at 2 p.m. The specimens can be inspected by anyone introduced by a member.

CANTOR LECTURES.

On Monday evening, 22nd inst., Mr. C. F. Cross delivered the second lecture of his course on "The Industrial Uses of Cellulose."

The lectures will be printed in the *Journal* during the summer recess.

HOWARD LECTURES.

Professor James A. Ewing, M.A., F.R.S., delivered the fourth lecture of his course on "The Mechanical Production of Cold" on Thursday evening, 18th inst.

The lectures will be printed in the *Journal* during the summer recess.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

Proceedings of the Society.

INDIAN SECTION.

Thursday, February 11, 1897; Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Member of the Council, in the chair.

The Chairman, in introducing the reader of the paper, said that Dr. Bose had distinguished himself in India, and had created an excellent impression in the highest scientific circles in England on his mission to Europe. After the papers he had read before the Royal Society, no further introduction was necessary.

The paper read was—

THE PROMOTION OF THE ADVANCED STUDY OF PHYSICS IN INDIA.

By Prof. Jagadis Chunder Bose, M.A., D.Sc.

On a recent occasion, at the foundation in this metropolis of a great scientific laboratory for research, it was observed that the pursuit of pure science was the most potent factor in the promotion of the intellectual as well as material progress of a nation and of humanity at large. Believing that the prosperity of my country depends in a great measure on the spread of scientific education, and the practical application of science, I shall in this paper try to put forward a few suggestions, by which, with a slight reorganisation of the existing institutions, the above-mentioned object could be attained. These suggestions relate to the simplification of the science course for the university examinations, the establishment of research laboratories, the foundation of post-graduate scholarships and fellowships for the advanced study of science and for research work, and the utilisation of the services of qualified students of science in the various scientific departments under the state.

The introduction of English education in India has been comparatively recent. Yet within a short time many Indians have distinguished themselves in the departments of law and letters. But in the department of science, the progress has not been so satisfactory. It has been a general complaint that young students in India, as a rule, do not take to the study of the exact sciences, which not only require the exercise of the highest imaginative faculty, but also a great amount

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of persistent and patient application. This apparent want of aptitude for scientific studies in our students has been noticed with regret by those interested in the intellectural development of Indian youths. The Government of India has on many occasions drawn the attention of the universities to the importance of encouraging advanced scientific work. Many members of the University Senate have also felt keenly that the present system of university education does not foster the proper development of intellectual faculties and encourage originality. I shall now proceed to trace the causes of the present deplorable state of things, and suggest how it may be remedied. I may here parenthetically remark, for the information of those who are disposed to take a too pessimistic view of things that the introduction of science-teaching in India has been very recent, and it is too much to expect great results in so short a time. Even in this country, which has had the advantage of a long period of scientific culture, the number of those who devote themselves to scientific studies is not very large.

I shall in the following observations make special references to the Calcutta University and the Presidency College, Calcutta, the latter being the most important educational institution under the Government of India. What I shall state in reference to these will apply equally well to the other Indian universities and colleges.

The teaching of science in India is greatly modified by the influence exerted by the universities. The Calcutta University was established on the model of the University of London; but while the latter has kept pace with the advance of science, modifying its course accordingly, the former has hardly moved with the time. In former days a natural philosopher was supposed to be an expert in all the sciences; science was then in its infancy, modern innovations were unknown, and a man could carry the burden of his multifarious knowledge without discomfort. Things are changed now, and it is impossible for a man to master thoroughly even a single branch of science in its various subdivisions. This fact has not yet been fully recognised by the Calcutta University. For example, in the B.A. examination,* the vast subject of physics, consisting of acoustics, heat, light, electricity, and magnetism, has not been thought large enough to be treated even as a single subject, but it is reduced to the status of half a subject. Though physics possesses merely a fractional value as a subject for examination, the text-books prescribed on it have been gradually increased in number and difficulty. This tendency to prescribe too many text-books without any due consideration as to the capacity of the students to master them will be exemplified from the following course laid down for the M.A. examination in Botany. It is to be borne in mind that this course is expected to be got through in one academical year.

> "BOTANY.—Asa Gray—Structural Botany. Sachs—Text-book of Botany, edited by Goebel. Balfour—Palæontological Botany. Roxburgh—Flora Indica. Sachs—Physiology of Plants. Bower—Practical Botany."

A botanist will understand the formidable nature of this course. It will perhaps be difficult to find even an expert who would be well versed in the different branches of botany as prescribed above.

The large number of text-books that has to be got through by the students in a short time necessarily leads to superficiality, and thus a disconnected mass of second-hand text-book knowledge takes the place of living science. To be supposed to have gone through so many high sounding text-books may feed the vanity of a thoughtless few, but such a system creates despair in the minds of serious students. The exercise of mere memory at the expense of the other faculties cannot but be attended with disastrous consequences. When the brain is crammed with a mass of apparently disconnected facts, without any order or sequence, the state of equilibrium becomes highly unstable, and the shock of an examination is enough to upset it. The strain on the candidates is so great that, in many cases, it permanently injures their health.

It seems to me that it should not be the aim of the universities to manufacture mere machines, but intelligent beings. We want to train our science students to think accurately, and to fix in their minds a few fundamental principles. We want to teach them how to use their hands, how to observe, and how to avoid errors. We would wish them, as far as possible, to find out things for themselves, and take very little on trust. We want them to feel that science and scientific experiments are not merely confined to the laboratories, but that in nature around them experiments of surpassing interest are being constantly carried out, if they would only see them. And, finally, we would wish to create in a few of them such a love for science that they may be entirely possessed by it.

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* The syllabus for the B.A. pass examination in science for 1897, as prescribed by the Calcutta University, is given below (compulsory subjects):—

I. English: Shakespeare—"The Merchant of Venice," "Macbeth," "Henry V." Burke—"Reflections on the French Revolution." Landor—"Selections" by Sidney Colvin. Palgrave—"Golden Treasury of Songs," Book IV. Milton—"Samson Agonistes." Pattison—"Life of Milton." Earle—"Philology of the English Tongue." Shaw—"Outlines of English Literature."

II. Mathematics: Statics, Dynamics, Hydrostatics, Descriptive Astronomy.

And one of the following:—

III. Physics *and* Chemistry.

IV. Physiology *and* either Botany or Zoology.

V. Geology *and* either Mineralogy or Physical Geography.

It will thus be seen that a student of biology for example, though compelled to take English and mathematics, cannot take up chemistry or physics.

What is wanted of the university is the simplification of its science course. At present the grouping of subjects is arbitrary and incongruous; this should be remedied. Greater importance should be given to practical examination and laboratory work, as in this way alone a student's real extent of knowledge can be tested. To encourage originality, degrees should be given for research work. This is being done by the Universities of Oxford and Cambridge with the best results.

A great drawback in the present system of higher examination in science is the difficulty of getting proper examiners to set papers. The University has perhaps rightly decided that those engaged in teaching science should not be elected examiners in their own subjects, as that might give undue advantage to the students under them. But this has given rise to a serious difficulty connected with the choice of examiners outside the teaching staff. Even experts in a particular branch of science find the greatest difficulty in keeping their knowledge up-to-date, and it cannot, therefore, be expected that any but specialists can always be acquainted with the newest developments of science which often profoundly modify existing theories. One way out of this difficulty would be to associate external examiners with teachers. Another way would be to ask scientific men from the English Universities to *set* the papers, the answers to which could be examined in India by properly selected examiners. Such inter-University courtesies exist here; for instance, the University of London often elects professors from the other universities as its examiners. In any case the real interest of the candidate—and by that I mean, a high and uniform standard of examination—should always be kept in view. It cannot be said in matters of science that the requirements of our students are peculiarly Indian. Such a supposition lowers the value of our university degrees, and we do not wish the scientific attainments of our graduates to be tested except in accordance with the highest standard prevailing in this country.

No real progress in science is possible in a country unless it aspires to take its due share in the general advancement of science. The cause of science is international, and its achievements are always attended with benefits to humanity. Thus on every nation worthy its name, and on every Government which represents it, is imposed the duty of furthering the bounds of human knowledge. Hence we see the establishment of national laboratories for research, and these are the institutions about which a State may well be proud. Even as regards the material prosperity of a country, it is now universally acknowledged that it depends greatly, if not solely, on scientific activities among its people. All the enlightened Governments are so fully convinced of this fact, that special encouragement is given "to those institutions wherein the highest branches of scientific instruction are pursued, and no money grudged for the equipment and maintenance of the science laboratories."* Of the obligations of the Government of a great empire like that of India, the development and the utilisation of the intellectual energies of the people are amongst the foremost, the Government of India has always recognised them. My present deputation to Europe to visit the different physical laboratories, with a view to improve our own, is due to the enlightened and keen interest taken in the advancement of science in my country by Sir Alexander Mackenzie the present Lieutenant-Governor of Bengal. Bengal has been fortunate in having three successive Governors who have been promoters of science.

For the promotion of physical research in India the establishment of a fully-equipped laboratory is, I need hardly add, most essential When any advance is made in a science, more and more difficult problems are encountered which require the construction of the most accurate and elaborate apparatus devised for their investigation. Merely qualitative results have hardly any value in science, and to render an investigation worth anything, it is necessary to obtain the most accurate quantitative results. In Europe the laboratories, fully equipped as they are, can easily command the services of expert instrument makers when necessary. The difficulties in the way of an investigator in India can hardly be imagined here. The physical laboratories that exist there are merely rudimentary. There are, properly speaking, no instrument-makers, and the commonest scientific materials are difficult to obtain. It is, therefore, all the more necessary to have in India a well-organised physical laboratory, equipped not only with the best instruments, but stored with scientific materials and provided with a first-class workshop, where the necessary apparatus could be constructed. While visiting the different laboratories here, I must confess to an unworthy feeling of envy, which took away all my pleasure. How splendidly equipped and organised they were; what facilities existed there for every kind of investigation! How the enthusiasm of the professor reacted on the students who worked under him; how the students learnt to take part in a great investigation at the laboratory; how each laboratory thus became the centre of scientific activity for generations of students! I cannot help hoping that for the whole of India we shall soon have at least one great physical research laboratory worthy of our great Government. To give an instance how such things are done in Europe, I might mention that in Germany the sum spent for a single laboratory often exceeds £100,000.

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* Report on a visit to Germany, presented to Parliament by command of Her Majesty, p. 10.

It may be asked if the Indian students have any aptitude for scientific work. I have heard it said seriously, as a proof of their inaptitude, that India has not yet produced a Davy or a Faraday. Now, it is forgotten that it took the whole world many centuries to bring forth a few men like Davy or Faraday, and it is somewhat unreasonable to expect India to produce such men before science-teaching has even been properly introduced. But I can mention instances which will show that enthusiasm and devotion for scientific work are not wanting among my countrymen. I may first cite the case of a very humble individual, who entered our laboratory as a menial servant to clean bottles and do other work of a similar description. He was so awkward in his new surroundings, that the laboratory assistant had no patience with him, and he was made to leave. Six months after he came to me in a half-starved condition, and I allowed him to work under me. For two years he kept his eyes open. One day, on the death of our expensive European foreman, he astonished me by asking permission to do the difficult work connected with the dynamo electric machines and engines, and he justified his request by his skill in working the machines. He had learnt some English by attending a night school; had become an expert photographer; and by some process which I can only describe as instinctive had learnt to arrange for me the most difficult experiments. Under the auspices of the Calcutta University, many moral text-books are brought out. I do not know whether in his readings he came across one of them in which the history of the great Davy, who began life as a bottle-washer, and afterwards became the most distinguished man of his time was given, but Nankuram who entered our laboratory as a washer of bottles is likely to remain so to the end of his life.

I have a young assistant who helped me most efficiently in the construction of apparatus for the study of electric radiation. He has a great enthusiasm for science, of which he gave proof by serving gratuitously in our laboratory for more than two years, though all this time he had to undergo great privations.

I shall have occasion presently to notice the fact that among the students a spirit of devotion to the pursuit of scientific studies is not wanting. I shall now mention instances of the actual accomplishment of important scientific work by some Indians. Thanks to the kind interest of the Government of Bengal and the devotion of Mr. Pedler, a chemical laboratory has recently been established in connection with the Presidency College, and within a period of less than two years Dr. Prafulla C. Rây has worked out in that laboratory a number of very interesting new compounds of mercury. Mr. Juoti Bhusan Bhaduri, M.A., has also done some excellent work in that branch of science. This activity is not confined to Bengal, but there are enthusiastic scientific workers in the other provinces as well, among whom I have the privilege of knowing Dr. Bahadhurji, of Bombay, and Mr. Nagamvala, of Poona.

The great difficulty in the way of our students in their pursuit of science, is that immediately after finishing their university examinations, which monopolises all their time, they have to seek for means of their livelihood. The student class in India, as a rule, are extremely poor, and often a family has to go through great privations to educate a boy. When a student finishes his university course, he feels himself in honour bound to support those who made such sacrifices for him. In any case he can not expect his family to support him after he has taken his degree. He is thus obliged to give up his further studies, and generally forced to the study of law, to which he is supposed naturally to gravitate. But I can state from my experience in many cases, that nothing is so distasteful to the science students as to give up science for law.

The laws of Nature, unfortunately, do not run on parallel lines to the very ingenious laws laid down by man, and one trained in the natural sciences does not, as a rule, find legal study a congenial one. Some time ago, one of my advanced students came to me in great distress, and asked me to give him some work to do, so that he could continue his scientific studies. His people were pressing him to pass the examination for the Bachelor of Laws, but he disliked the profession of law, and was determined to fall ill on the day of the examination. I have not yet found his name among the list of successful candidates for the Bachelor of Laws.

Seeing that the only time when students can profitably devote themselves to the advanced study of science is after they have been set free from the examinations, the question arises how they might be enabled to do so, and how their trained services might afterwards be utilised by the State. As regards the first, if we wish to see in India any true scientific advance made, it is absolutely necessary to have post-graduate scholarships and fellowships, to enable successful students to pursue their advanced studies. The importance of this is, I am glad to find, recognised by some prominent members of the University, and a movement has been set on foot to remove the present want. Every one interested in high education would wish this movement every success.

With the establishment of a research laboratory, and a number of devoted students working in it, there will be opened a glorious prospect for the future of scientific activity in India, an activity which cannot but react most favourably on the various industries. At present there are many difficulties in their way. In the extension of the electrical industry, for example, the electricians in India complain that many things that work well in England do not succeed in India, and they lay the blame on the climate, all mischief being ascribed to the excessive heat. It seems to me that difficulties were made to be overcome, and if we have trouble in India in connection with heat, you in England have to contend against frost; but you successfully overcome it. Difficulties must arise when a thing is introduced under new conditions, and they can only be overcome by men who specially devote themselves to their removal. These requirements can only be successfully met by men who work in India, who understand the conditions, and who under the given circumstances can intelligently work out a solution. This would be but one of the many ways in which a research laboratory would be useful.

It strikes me that the prosperity of your country depends not in a small measure on the devotion and activity of men of science, and the practical application of science. I wish similar beneficent activities would spread in my country. Nature is bountiful to us, there is vast wealth buried underground, and there are powers which are running to waste. It only requires the touch of science to bring them to the service of man.

The advanced students whom we hope to train in our laboratories will form the best material for the recruitment to the various scientific departments under the State. The students who now work in electric science in our Presidency College laboratory acquire a very high efficiency in it, and it would be an advantage to the Telegraph Department to utilise their services. Indeed, this was at one time contemplated, and Sir Alfred Croft, the retiring Director of Public Instruction, interested himself in it. It is to be hoped that something will be done in this direction.

One suggestion more before I conclude. For scientific activity in India, the intellectual community out of which the future men of science are to arise, should be kept in touch with the most recent progress in science made in any part of the world. Science can only become a dominating factor when there is an eager thirst for knowledge, and there are means for satisfying it. I need not here mention the influence exerted by the Royal Institution on the intellect of this country. The University or the Presidency College can do a great deal in this direction by annually organising courses of lectures on the most recent advances of science.

I have not yet said anything of the intellectual hunger that has been created by the spread of education, a hunger which is as imperative as that of the physical body. The *Spectator*, in a recent article, has well remarked that an educated man in my country wants something absorbing to think about.

His intellect is at present left to consume itself, there being no vent for his useless energies. If it could be done he would betake himself "ardently, thirstily, hungrily, to the research into Nature, which can never end, yet is always yielding results, upon which yet deeper inquiries can be based." We have been called a nation of dreamers. There is a necessity for dreamers to think out the great problems of life, and make the world richer by their thoughts. But there is room for workers, too, toilers who by incessant work would increase the bounds of human knowledge. We want to have our share in this work. Our ancestors did at one time contribute to enrich the stock of the world's knowledge, but that is so long past that it is almost forgotten now. It would perhaps not be an unworthy work for England to help us to take our place again among the intellectual nations of the world.

DISCUSSION.

Dr. J. H. GLADSTONE, F.R.S., said the practical view taken by Dr. Bose of scientific teaching in India would no doubt have great influence in dealing with the question there, and would also have a reflex action on our own educational system. From small beginnings a vigorous life often followed, and as yet this question was young in India. Metaphysical as the Indian mind was, the teaching of modern science could be successfully taken up, and though the subject was comparatively new, laboratories richly endowed with apparatus were springing up in India. The methods of mediæval science which had grown up with the world's history, had been to a great extent overthrown in this country, and it was desirable to save the trouble of having the same battle over again in India. Examination of students upon mere book knowledge was a recognised mistake, and people should be taught to observe what was going on around them, and what would be useful to them in their future lives. He had been much struck with the great enthusiasm of the boys in one of the poorest of our East-end schools, where they were taught not by books, but to make experiments for themselves and to use their fingers as well as their minds; and though they might not turn out to be philosophers, they would be more capable afterwards—even as bricklayers or costermongers—of doing the ordinary work of life. A committee of the Technical Education Board had recently made a valuable report on the teaching of chemistry. That report would effect a revolution in teaching chemistry and physical subjects. Such teaching should be directed, not so much to the acquisition of specific information, as to give a bent to the students' minds in order that they might be guided to acquire information for themselves in the future. In that way they would be made better members of society, and what was taking place in England would result in other parts of the world through the beneficial agency of men like Professor Bose.

Professor WYNDHAM R. DUNSTAN, F.R.S., having referred to the high ideal of the paper, said the first point to emphasise was the importance of securing special teaching in connection with elementary education. So far we had been largely on the wrong tack. Everybody could not become scientific specialists. The reports by the British Association Committee had pointed out that the great object must be to inculcate scientific habits of mind, and not merely to acquire scientific facts, and this would necessarily require a much higher class of teachers. Securing competent science teachers might be of great difficulty in India, which was at a disadvantage in being cut off from European influences. Dr. Bose had said the best examiners were external. He thought, however, the most satisfactory examiner of students was the man who had taught them. But if in the case of India it seemed desirable that external examiners should be appointed, so that the Government and teachers there should be kept *en rapport* with what was going on in Europe, there ought to be no difficulty about it.

Professor H. E. ARMSTRONG, F.R.S., said no subject in connection with the empire was of greater importance than this. As Dr. Gladstone had said, India would have the advantage of considerable experience to guide her in the direction of what should not be done, seeing how we had burnt our fingers. It was desirable to maintain touch between teachers in England and in India, a co-operation which might be secured without trenching on the examinations. From his experience in the Oxford and Cambridge examinations he would say that the external examiner was one of the most unmitigated evils in the education of this country, and there was no reason why teachers should not be allowed to examine their own students. He hoped the recommendations in the paper in that regard would be reconsidered. The absurd system which had tied our hands in this country should be given up, and pupils should not be allowed merely to get their minds chock-full of what other people had done, and lose the power of thinking for themselves. The very spirit of the reports referred to was that students should be encouraged to work from the research point of view from the beginning.

Professor A. CHATTERTON, as an officer of the Educational Service in Madras, congratulated Dr. Bose on the valuable work he had done in science during the last few years. That gentleman had referred to the difficulty of developing a taste for science among the natives of India from his experience in Calcutta. He (the speaker) had found in

Madras that the high caste natives, who formed the majority of the students, had shown no aptitude for scientific work, more especially in regard to engineering, and they spent as little time as possible in laboratory work, wasting their time and showing a want of mechanical skill, though not deficient in intellect. With extraordinarily retentive memories, and rapid learners, they never used their hands. Insufficient attention was given to the working of hand and eye together. In Madras, efforts had been made to remedy the defect by establishing manual workshops for the students. The ordinary native student was unobservant, and relied upon books and lectures for acquiring knowledge. Much had been done in the last ten years in spreading scientific knowledge all over India—considerinng the difficulties in establishing laboratories and places for carrying on scientific work. The extreme poverty of the country was a great drawback, and the educated classes in India looked upon education from an entirely different point of view to ours. The natives regarded the Government services as the goal they would attain. Climate was another element of consideration in this matter, and it was a wrong principle to try and copy to the full extent the methods of scientific teaching which had been adopted in England. Laboratory work could hardly be carried on successfully in a temperature of 85°—95°. As to the appointment of external examiners, an attempt in that direction had been made in Calcutta, but it was found to be a complete failure, and after a year's experience they returned to the old system of appointing professors and lecturers in the various colleges to assist in the examinations. In Madras no difficulty of that kind had occurred, the board of examiners being composed partly of men engaged in teaching, and partly of eminent specialists who might be there at the time. There would, he thought, be difficulty in working with examiners living in England, who would hardly know the conditions under which students were working in India; and the delay involved would be almost fatal, seeing the importance of the prompt publication of examination results. One of the greatest difficulties was the want of suitable teachers of elementary science. In a country like India the best system would be to carry on simple work with simple apparatus, and probably teaching some such science as botany would yield better results than elementary chemistry or physics. At present the country was too poor for taking up science to any great extent, and the scientific training of natives should be such as to afford them scope after passing through their student days.

Mr. P. C. ROY (of Calcutta) said he rose to say one word in reply to the last speaker, who remarked that the Hindus prefer studies which require the exercise of the brain only to those which require the exercise of both brain and hand. He (Mr. Roy) wished to refer Prof. Chatterton to the engineering and medical colleges, and to the arts' schools, which require students to exercise both their hands and brains. All these institutions are as much resorted to by the Hindus as the colleges for general education. The Hindus, moreover, come to England to study medicine and engineering. A Hindu student from the Calcutta Arts School came not long ago to study painting and sculpture in Rome, where he won medals and prizes. Another Bengali had, he (Mr. Roy) was told, come there with the same object.

Mr. DADABHAI NAOROJI said that the average of Indian and English youths had the same desire for learning, but the great difficulty was the want of opportunity and the poverty of the people. The richer classes failed to see the advantage of higher culture, either in science or literature; and were satisfied with having sufficient means of providing for their families, without troubling themselves about mathematics or physics. In the circumstances under which poor students worked, they might almost be considered heroes. The Indian race were remarkable for their love of learning for its own sake, and acquired it often on the smallest modicum of rice. The idea that the Indian mind was incapable of scientific culture, both abstract and experimental, had now been amply refuted, but means and opportunity were wanted. It was adding insult to injury for people to talk of inaptitude and incapacity of Indians, of whom they knew nothing. Students should be given in their colleges fundamental knowledge in each branch of science, so that afterwards they would know how to develop their talents to the fullest extent. There was no doubt of the ability of Indian students to pass scientific examinations, and their subsequent lapse was attributable to want of opportunity and means, and other causes altogether.

Lieut.-Col. ALLAN CUNNINGHAM, R.E., said he had had eleven years' experience at the Thomason College at Roorkee, the largest engineering college in India. Very few of the native students from that college could be said to have shown much taste for practical work such as engineering or experimental science, and very few had excelled therein in after life; but the fact was that the men who came to the college were chiefly those in whom the literary instinct was already developed. It certainly, however, could not be said that the natives of India were really deficient in the sort of brain-power necessary for original scientific research; there was plenty of it among them, but there was very little opportunity for calling it out. And he must beg leave to disagree with a previous speaker as to the natives of India being deficient in manual skill. The writer class would of course have little; but that manual skill had attained high development among the "mistree" class was amply shown by the exquisite carvings and other ornamental work to be seen everywhere. The real difficulty about scientific research had been, and was still the want of opportunity; that opportunity could only be afforded by the provision of good laboratories, and laboratories were very expensive things. Where was the money to come from? It would not be right to look to the Government to provide it. If men like Dr. Bose would try to arouse the wealthier natives to an interest in this movement, they might be induced to provide the funds for laboratories and scholarships, and the Government might afterwards be asked to give some help. A beginning might be made by opening the existing laboratories of the Presidency Colleges, and perhaps of Engineering Colleges, to students who showed the wish and the ability for scientific research. As to outside examiners, no difficulty had been found in the Thomason College; and surely joint examining boards could be formed from the professors of the various colleges and other scientific men in India without resorting to England.

Dr. WILLIAM GARNETT said an object-lesson had been furnished by Professor Bose's lecture at the Royal Institution last Friday week of what could be done, both by the intellect and the hands of Indian workers, under very difficult circumstances. During the last twenty years he had had the privilege of counting among his friends a number of natives of India, all university men. He had lately been inquiring into the curricula of Indian universities, and had found complete unanimity among natives of India in regard to cramping the native intellect by examinations and text-books. He was not one of those who wholly condemned examinations, as he believed they had a mission to fulfil, so long as they were regarded as a means and not as an end. He thought that the examination for county scholarships was doing as much for improving the science teaching in secondary schools in London as was being done through the reports of inspectors or the payment of direct grants. In this country the universities and the public elementary schools had shaken themselves free to a large extent from the trammels of examinations and of text-books, and the science and art schools were endeavouring to follow their example. If he might travel as far as from the Indian universities to the public elementary schools of London, he would like to urge the desirability of striking out all the science subjects from the schedule of specific subjects in the Elementary Code and replacing them by a single subjcct which should be the foundation of all elementary experimental science. If it were desired that the natives of India should continue to respect Western education it would be necessary to endeavour to induce the Government of India to modify the curriculum of the Indian universities so as to give the students of science the opportunity of coming into actual contact with nature and learning directly from experiment. With reference to the complaint that India had never produced a Davy or a Faraday, he would point out that Sir Henry Roscoe, a few days before, had reminded an audience that it required a Davy to find a Faraday, and if we wanted to pick out the Faradays from among the natives of India, we must provide the necessary machinery for the purpose.

Mr. M. M. BHOWNAGGREE, M.P., congratulated Dr. Bose as a distinguished Indian scholar on his valuable paper. India had of late years made some stride in scientific development, and he would instance on the Bombay side Professor Nasgamvala, Mr. Moss, and Dr. Surveyor, who had been doing valuable scientific work. As, however, Dr. Bose pointed out, the natives had not sufficient opportunity for following those pursuits upon which after all their regeneration of the country must depend. No doubt the Government might do more in that direction, but the people of India should perform their share of the work. A considerable class of Indian students and their parents had that in their power, though the great mass of the people were no doubt poor, and the conditions of educational development in India were very different from those existing in this country. Students finished their scholastic or university course as soon as possible, and left off all study to provide for the want of their families. In many cases that was a necessity, but it was not always so, and it should be impressed upon them that the purpose of university teaching was not that they might become bread winners for their families as soon as they possibly could. Honourable exceptions existed to the prevailing rule, and their country benefited from their continuing the intellectual pursuits of their younger days. But sons of successful tradesmen and others, who had received a good education, never aimed at going back to their fathers' occupations and developing them as was the case in England, and that was exactly what was wanted in India. Even agreeing in what had been said about the poverty of the country and the want of opportunities for students, and allowing it to be the duty of both the Government of India and the Provincial Governments to use their best endeavours to encourage scientific and industrial education, he thought a reciprocal duty lay upon students and parents to foster scientific and industrial training. It was idle to talk of inaptitude among the natives of India, and the sooner that notion was got rid of the better. He was very glad to see that the energies of teachers and students had been stimulated by the encouragement given them by the Government of Bombay, by founding the Victoria Technical Institute, and if the same thing were done in other parts of India, scientists would be produced from among the natives not less capable than those of Europe. About a month ago he visited that Technical Institute, and could bear pleasing testimony to what the labours of quiet workers, of which its secretary (the Hon. N. N. Wadia) was a type, could do for the promotion of scientific and technical pursuits. It was men like him and others who made that Institute successful, that India needed for the fulfilment of such aims as Dr. Bose had in view.

Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., observed that at that late hour he would much rather not detain the meeting longer, especially as anything he would have desired to say on the subject of Dr. Bose's paper had been said by previous speakers of infinitely greater ability than he could command. But as he had been called upon to speak, he could not sit down without saying how cordially he concurred in every word that had fallen from Mr. Dadhabhai Naoroji and Mr. Bhownaggree and from Colonel Cunningham, as to the equal natural competency of the natives of India with Europeans in scientific studies and research. There were, indeed, circumstances which hampered the former in the pursuit of such studies. One was the simplicity of their lives. Native children of certain classes were not trained, like European children, from their earliest years to the use of their hands in the innumerable momentary incidents of our daily lives. The toilette of a Hindu child was simplicity itself, while nothing could be more complicated than that of a European child, necessitating the constant use of his hands in putting on and taking of, and buttoning and unbuttoning, and tying up and untying, all sorts of habiliments, combing and brushing the hair, &c. There was the same contrast between the meals of native and European children, the former having to use their hands directly in lifting food to the mouth, while the latter had to learn the use of such intermediate implements as spoons, knives and forks, &c. All this more complicated early training in the use of the hands told in favour of European children in developing their natural aptitude, almost from infancy, for the mechanical work involved in scientific studies. But to say, therefore, that the natives of India were naturally deficient in the use of their hands—were, in fact, hopelessly unhandy—was sheer nonsense. The Hindu castes trained to mechanical work, as in wood and stone-carving, in metal work, enamelling, and jewellery, in weaving, in pottery, &c., had by the universal consent of history been regarded as superior to all the rest of mankind in tactile sensibility and manipulative dexterity, and, in a word, in every form of manœuvre ["manu-opera"]. Then take your native servants—how marvellously they modelled pie crust, and pats of butter, and arranged your nosegays—true "posies"; and they never broke your glass and china; in fifteen years they never broke any of his. Another circumstance that had hitherto handicapped the higher castes of Hindus in the study of modern science was the severely scholastic form of their indigenous education, which gave a marvellous development to the memory, to the detriment of the other powers of the mind. And again, the practice of early marriages, involving them prematurely in the absorbing cares of a family, and the prevailing vegetable diet of the people, tended to divert and debilitate the very faculties of the mind, the vigorous concentration of which on its objects was essential to all intellectual success in learning, literature, or science. India was latently the richest country in the world, and supported a population of over 250,000,000; but until the latter universally took to eating more animal food, and agreed to delay marriage to 25, or until their bones were really ossified, they would never do justice to the natural reproductive forces represented by the vast, outstretched extent of their tropical and sub-tropical country, and by their own teeming numbers, and the potential prosperity of India would remain an idle dream. But, after all, the chief cause of the tardy development of the teaching of modern science in India, apart from the late date of its introduction into the country, had been the inevitable deficiencies of the teaching staff at the start. It was little more than fifty years ago that the machinery of scientific education was set in motion in India, and at the first the Government had to use the men on the spot for the purpose; and so when, forty years ago, he joined Grant Medical College, Bombay, he found that, while the students of botany knew all the flowers in Balfour's Manual, they knew nothing of the flowers in their own gardens and fields; and that, although many of the most famous drugs in the British Pharmacopœia are Indian, the students of Materia Medica knew them only from the dried specimens imported from England, shown in the College Museum, and not as they flourished spontaneously all round about them, the castor-oil plant, for instance, growing in every hedgeside of the island of Bombay. The aim of his predecessor in the Chair of Materia Medica had apparently been limited to turning out efficient regimental apothecaries; and talking of handiness, nowhere will you find more skilful "dispensers" of drugs that those same native regimental apothecaries. He (Sir George Birdwood) recollected, at his first examination, asking the class, "Where the drug aloes came from?" and the unanimous reply was, "From the medical estores." He then asked, "How is the drug extracted from the aloe plant?" and again the competitive shout was, "By an indent on the medical estorekeeper." But this was at the beginning of the beginning. Since then scientific teaching has been wonderfully extended and improved in India, and the Government of India was always ready to extend it if satisfied as to the results to be obtained; and Dr. Bose might rest satisfied that one of the strongest inducements with the Government of India to do yet more in the future than in the past for scientific education and research will be his own brilliant success as an original and practical scientist. He would only add the expression of his earnest hope that in the future Dr. Bose would more than fulfil the bright auspices of his present enviable reputation.

The CHAIRMAN thanked Dr. Bose in the name of the meeting for his valuable paper, which had given rise to one of the most interesting discussions he had heard at the Society of Arts.

Dr. Bose, in acknowledging the vote of thanks, said, in reference to examiners, that the University of Calcutta would not appoint teachers in that capacity. The choice lay between men who knew something of the subjects and people who were merely amateurs.

Colonel R. G. Woodthorpe, R.E., C.B. (Survey of India Department) writes under date, Feb. 11:—I should have liked to say a few words this afternoon suggested to me by what fell from one of the last speakers, but I had not an opportunity of saying them. My remarks would have been to the effect that while we are, by our warm reception of Dr. Nansen, showing our high appreciation of all the great qualities which mark a true explorer, I would recall the splendid services performed by those natives of India who, trained by the Survey Department, showed by their good work among the snows of the Himalayas and elsewhere, often under circumstances of great hardship and privation, that they also share those powers of endurance, that pluck, resourcefulness, determination and tact, which no less than scientific attainments are necessary to all successful explorations. We have many good men in the Survey of India who do the greatest credit to those officers by whom they have been trained, and their fame has so spread abroad, that when explorations are undertaken in distant parts of the world, *e.g.*, Arabia or South Africa, attempts are made to secure the services of some of these men, whose names or the initials under which they worked are so well known now in the geographical world.

APPLIED ART SECTION.

Tuesday, Feb. 8, 1897; Joseph Pennell in the chair.

The Chairman, in introducing Mr. McCulloch, said lithography was no new thing to discuss in that room, for eighty years ago the work of Senefelder was awarded a gold medal by the Society, greatly to its own honour and also to that of the eminent person who invented lithography. All that had been done since was to improve certain methods of expression. The Society had always taken considerable interest in the subject, and in 1891 Mr. William Simpson, an artist and lithographer, read a paper before the Applied Art Section which he called "A Finished Chapter of the History of Illustrative Art." Mr. McCulloch would show them that evening that the chapter was not yet finished. This gentleman had produced a number of designs which were perfectly charming; he knew all about the theory and practice, which was much more than many of them could say. But before calling upon Mr. McCulloch he would ask Mr. Way to give his practical demonstration.

Mr. T. R. Way said that he wished to show the process of transferring to stone a drawing made on transfer paper, and he should endeavour to show before the close of the evening an impression from the stone of the drawing. He held in his hand a drawing which had been made by Mr. McCulloch for the purpose of that experiment. It was made with ordinary lithographic chalk on prepared transfer paper. Transferring it to the stone was not a very lengthy process, but in the ordinary course of things it should be left for 24 hours before it was handled again, in order that the fatty matter in the chalk might thoroughly settle in the stone, and the gum with which it was covered should become thoroughly dry. As they could not afford to stop there 24 hours he would put the drawing on the stone while Mr. McCulloch was speaking. The drawing was placed between clean sheets of damp paper until it was moist; it was laid on the stone face downwards, and pulled through the press, and then the sheet of paper would be lifted clean off the stone. The actual strokes of chalk made by the artist could be seen standing on the stone, the only change being that the drawing would be reversed.

The paper read was—

LITHOGRAPHY AS A MODE OF ARTISTIC EXPRESSION.

By George McCulloch.

At the request of the Applied Art Section of the Society of Arts, and on the suggestion of my friend William Simpson, I have undertaken to read a paper on "Lithography as a Mode of Artistic Expression," and I crave your indulgence the while I do so.

When in January, 1891, lithography having been in a bad way for many years, Mr. Simpson read his paper on "Lithography; a Finished Chapter of Illustrative Art," in this room, he therein stated that for illustrative purposes lithography was not moribund but dead. Although he considered it as illustratively dead, he thought there might be a future life for it, if only artists of ability would take it up. It has been taken up by artists of ability, both here and on the continent, and there is now a distinct revival of the art. There are societies in Paris of lithographic painters; there are none here at present, so far as I know, but there are artists of ability stirring in the matter, and there is hope, that the ideal of my friend, of trained artists working in lithography is about to be realised. In Mr. Simpson's paper he said lithography has so many methods offering facilities for variety of effect, that if experienced artists could only be induced to take it up, they would not be bothered wtih etching, for in working on stone you see what you are doing, which is not the case with the etcher, and he expressed the conviction that if artists were familiar with what can be effected in lithography they would adopt it, and by its means produce work that would be their own in tone, touch, and all other qualities that belong to art. He was sure that with two tint stones, either a black or a brown as etchings are now printed, any effect could be produced, and depth, power, and delicacy could be given.

In the *Magazine of Art* for January, 1897, M. Spielmann almost echoes Mr. Simpson's utterances of January, 1891. He says, in speaking of the public coquetting with the etching plate for some twenty years, "But it was impossible that a method offering such splendid range to the artist should be entirely neglected; impossible that a process which offered a technique more extensive than any other form of black and white, should be willingly given up. 'As flexible as etching,' it could give nearly the whole range from velvety black to dreamy grey as with mezzotint; it could be a chalk drawing, a wash drawing, a pen drawing, a stump drawing, an aquatint, what you please." "It was autographic, and even the ordinary drawing with the pencil offered the greatest attraction to the true artist, to whom the slightest sketch, if artistic, would be often worth more than the biggest picture."

In the discussion that followed on the reading of Mr. Simpson's paper, Mr. Orrock "could say with perfect truth that there was no medium at all which had done so much for the English landscape painter as lithography. John Ruskin admitted that Harding's works on trees were probably the finest things the world had ever seen. Sydney Cooper's cattle lithographs—produced about sixty years ago—had been most valuable to the landscape painter. Lithography was a living art, and he was quite sure, would never die." Sydney Cooper is still alive, and these lithographic notes of cattle are not surpassed by any cattle-drawings known to me, and I do not know of any mode of artistic expression that can rival lithography in such work.

In treating of lithography as a mode of artistic expression, it is unnecessary to enter into a history of Senefelder, his struggles, his washing bill, and how through it he stumbled on and perfected lithography. How he found the Solenhofen stone capable of a high polish and fine granulations, absorbent and retentive of grease, how the greased granulations refused water, while the ungreased parts, between the granulations, held the water and refused the grease on the charging roller. How a little gum and acid penetrated between the granulations and prevented their spreading laterally; all this and more, pretty exhaustively, is to be found in Mr. Simpson's paper read to this Society in 1891.

All that an artist need know, is, that lithographic chalk, used as a pencil, can do all that can be done by the lead pencil, and that as a shorthand for artists of ability, it offers a medium of translation, not so foreign to their fingers as the etching needle. All the rest may be safely left in the hands of a capable printer.

Lithography lends itself not only to a somewhat masterful, suggestive mode of expression, but also to the most finished work.

Talking to Mr. Whistler about lithography, and the reversing difficulty—a difficulty shared with the etching on copper—and that a work must be reversed, he said, "not necessarily." If a work is beautiful or desirable, it is of no consequence whether it proceeds from right to left, or left to right. If it is good art, it is right either way.

Of this lithographic difficulty, we are told that Baugniet, who drew from life on stone, or rather drew from the image of his sitter in a looking glass, got over the difficulty in that way.

This difficulty is, however, practically done away with by drawing on a properly surfaced lithographic paper. The drawing having to be laid face down and transferred, the work comes out when printed as drawn.

As a splendid example of lithography as a mode of artistic expression, I beg to draw attention to a very delightful little image of a nudity by Mr. Whistler now hanging in this room. It is to me unspeakable in its grace and suggestiveness. The feet are only indicated, but the indication is so vital, that I do not believe Mr. Whistler could put a line round them, or do anything to suggest the life of the feet with more acceptance to save his life; and I am thankful he had the genius to leave off when he did. It is a wonderful example of lithography as artistic shorthand; of artistic reference—not completion. It was done on lithographic transfer paper.

I suppose a delight in common completeness is only possible to those to whom insight is not given, only outsight—if I may coin a word—shortness of sight, to whom art is only a fine workmanship. This incompleteness is not necessarily an evasion of a difficulty, for it may be deliberate. The losing and finding does not apply to the outline only; revealing and concealing are both necessary in true work. Artists often value their notes of hand, notes of intention more than their completed work; their undogmatic utterances more than their deliberate speech, so to speak. They are greater than themselves the while—and if the "Go," as it is called, could be kept up to the finish, we would take the work to our hearts, and live with it, to our great content. But the moment that effort or labour is apparent, and a painfully acquired knowledge is in evidence, our ideal suffers. I believe even the great Turner, on whose work there is to us no evidence of weakness, for power is over all—an overmastering power—though labour is nowhere in evidence—that he stooped rather than strove; that he did not value himself highly, that he was not satisfied, and therefore could not be conceited, that he so knew the greatness and the littleness of all endeavour, was so conscious that the possible is more than the actual, always; that although always unsocial and intolerant of others, he was in his way humble.

But this is not lithography, as a practical or an applied art. Drawing on lithographic transfer paper is not of course, in an actual sense, drawing on stone, but the practice was contemplated from the first by the inventor, as a mode of putting drawing work on stone, and the printed result is of course, a lithograph. Although a drawing on the paper cannot compete with a drawing on stone for velvety richness and depth, a darkness that is not as a wall, a darkness that seems, as it were, to palpitate—reverberate is a word I have a desire to use in speaking of this rich darkness—I do not know of any medium for artists so invaluable as the transfer paper for notes of hand, to be treasured in portfolios like etchings, and turned over now and then for solace.

The reversing difficulty is a hindrance to pure lithography—that is, the working on stone, but that is a difficulty shared with every mode of reproduction, except reproduction by lithographic transfer paper, and I do not know of any medium that lends itself so directly to the artist, as drawing on the lithographic transfer paper.

Autograph and autolithograph are names proposed by which to designate drawing on transfer paper; every drawing is an autograph if done by hand. I think that papyrolithograph would better express the share the paper and the stone have in the work, or papyrolith.

There are specimens round the room to-night, wherein the stump, the wash, the chalk, the scraper, have been freely used. The Isabeys are all good; in them the velvety-mezzotint quality of the darks is very delightful. In many of these drawings, the poor stone has been so tortured, scraped, worked over with chalk, stumped, washed and half scraped, that it is wonderful any self-respecting stone can make so handsome a return.

The earliest lithograph on the wall is by C. Varley, 1809, a pen and ink drawing, but whether penned on stone or transferred is not known, and there is a David Wilkie lithograph which must have been largely helped by a professional, because the evenness of the tinting on the turban could not have been done by one unused to the stone—nervousness would forbid it. I believe, however, Wilkie did work on it. The oriental jacket bears evidence of a quality not to be expected from an ordinary workman; and he has spoiled the professional work on the background, in attempting to increase the depth. The face alone would require considerable familiarity with the stone to produce. There is a J. D. Harding as early as 1825, and very fine, from the lithographer's point of view, and the difference of this work from the work in evidence in his "Park" and the "Forest" is very great, a work which extorted the praise of Ruskin. There are Prouts, dated 1820-21. There are works by L. Haghe, of date 1830. There are Raffet's, between 1830 and 1850. There is a "Bull," by Lavis, lithotint or wash or stump, a puzzle to know how it was done. There is a Sirony, of date 1855. "The Lansquenets," beautiful work, but lacking the colour quality. There is a "Catherine the Second," by Grevedon, dated 1827, very fine. There is a Deveria, drawn on a rather flat-grained stone. Another Prout, 1821. There is a Baugniet, of date 1844, of Sam Lover, dry work, lacking quality, expressing flesh. There are two wonderful aqualithotints. M. Spielmann uses in the *Magazine of Art* the word aquatint as meaning wash drawing. There is no process reproduction that I know of that can rival these two for delicacy and beauty. They are architectural drawings. The printing is a marvel, and the wash stain is as delicate as any stain left on an etching plate. They are finer in delicacy than mezzotint, that is, in the high tones.

Sir J. D. Linton, who presided when Mr. Simpson read his paper in 1891, said, "The idea had been ventilated whether there might be a revival of the processes which should be artistic and commercially valuable; litho-tint seemed to him admirably adapted for the purpose. Cattermole worked in litho-tint; and one of the finest works of art Frederick Taylor ever produced, was a litho-tint of a boar hunt. He could not help thinking that if litho-tinting were treated in the same way artists now treated etchings, it would meet with the same success."

I have seen etching done on stone, the lines scratched through a blackened ground imitating etching, and I have seen impressions of German business circulars, splendidly engraved, the writing characters equal to copper, engraved on stone and printed like copper, the ink sneaked into the hollows by a broad inking dabber—not a roller. I have seen work printed by Kell, of Covent Garden, of machinery engraved on stone equal to copper line engraving. There is, however, no likelihood of artists taking to this mode of lithographic artistic expression.

Amongst English portraitists, R. J. Lane, A.R.A., stands foremost. There is a very fine portrait of a Miss Taylor (actress) from a drawing by Chalon, and a portrait of George IV. in armour, which is curious, besides others. Lynch comes next. There is a "Garland of Flowers" by Francais, very fine. There are some things by H. Vernet, which are curious, and many good things by Deveria; portraits of Victor Hugo, Dumas, &c.; an Edouard Frere, a curiosity, not otherwise notable; a very fine Robert Carrick. Other famous names are in evidence, Ferogio, Hervier, Daumier, Renouard, and the very distinguished Menzel, who is represented by a very fine thing in lithography, and there are works ranging from 1809 to now, a very fine gathering indeed. There is a showy, stagey, bravura sort of drawing by I don't know who, but it is amongst the Cattermoles as a possibility. The velvety quality of the dark in this drawing is really wonderful. The stump has been used largely with the chalk.

Assuming that a mode of artistic expression is a necessity to all in this room, at least. I may say that I have sat behind a gentleman here, an architect, who, the subject being Stained Glass, denied that colour had power to strangely move us. I presume, called upon to build churches, he would have filled the windows with stained glass professionally, without the remotest idea of its soul value. Professionalism is dogmatism, and, within limits necessary. It can certainly make mediocrity more respectable; and if we can't have genius, it is good to have the respectable.

This unabashed assertion of colour-blindness astonished me; having in mind the story told by the then lecturer, when lectureing in another place, of an emotional little boy, held in love and wonder, and some awe, in front of a splendid window, who, when the organ, enriching silence, broke into sound, started; it was as the voice of the window.

It is always so, splendour to eye or ear are but the equivalent of each other, according as we have ears to hear, and eyes not colour-blind, but modes of expression for the same hope of rightness, breathing peace, a peace that passeth all understanding.

Amongst the latest workers in lithography stands Mr. Whistler, whose drawings speak for themselves and need no words of mine, and Mr. Pennell, whose sunny notes of hand are notable and fine, and there is a worker in artistic lithography whose works are not here, and there are drawings by Rothenstein, and a published work of his, and another lithographic publication by Holloway and T. R. Way in evidence of a revival of artistic lithography; and I do not think I ought to close without alluding to T. Way, the expert, who never lost hope of lithography, and has spent time and money in the cause.

Leaving to the fine show on the walls what further recommendation is necessary of lithography as a mode of artistic expression, I thank you for your patience, and trust I have been of some use.

A fine series of historical and modern examples of lithographs was collected and arranged on the walls by Mr. T. R. Way, largely drawn from Mr. Pennell's collection. These included works by R. P. Bonington, T. S. Boys, G. Cattermole, C. Francis, L. Haghe, J. D. Harding, R. J. Lane, Lynch, J. Nash, S. Prout, J. Varley, Sir D. Wilkie, — J. Bacon, R. Carrick, Mark Fisher, C. Green, E. J. Gregory, A.R.A., C. E. Holloway, Sir J. D. Linton, G. McCulloch, J. Pennell, L. Ravenhill, W. Rothenstein, F. Short, W. Strang, T. R. Way, J. A. McN. Whistler, — Baugniet, Charlet, H. Daumier, A. Deveria, Dillon, Fantin, Français, Frère, Decamps, Gavarni, H. Grevedon, F. Hauftstaengl, Hervier, Eug. Isabey, Eug. Lamy, A. Menzel, C. Nanteuil Neglez, Raffet, A. Sirony, Ary Scheffer, C. Vernet, H. Vernet. Besides these were exhibited the following illustrated books:—Albert Durer, Christlich-Mythologische Handzeichnungen, illustrated by lithographs, drawn by Strixner, two volumes illustrated by Gavarni, Yvette Guilbert, by H. de T. Lautrec, Oxford Characters by W. Rothenstein, W. Irving's Tales of the Alhambra by J. Pennell, Reliques of Old London by T. R. Way.

DISCUSSION.

The CHAIRMAN said Mr. McCulloch had been fortunate enough to secure the attendance of a large number of those who had much to do with the revival of lithography, and the carrying on of Senefelder's story. That being so, he thought an interesting discussion might be expected. Among the many artists present he noticed Mr. Whistler, and would ask him to make a few remarks.

Mr. WHISTLER said the paper to which they had listened was so good that there was nothing left for him to add.

Mr. F. GOULDING said he had lately been making some experiments on this subject, with more or less successful results. As a printer, he thought lithographic printing—sometimes—might be treated in a freer sense than usual—a printer of etchings used his rags as tools to produce various results from plates—and he thought that something analogous might be done in producing proofs from the stone.

Mr. F. VINCENT BROOKS said he was present when Mr. Simpson read his paper, and upon that occasion a more debateable ground was taken up than upon the present. Mr. McCulloch had pointed out that things were not quite as gloomy as Mr. Simpson tried to prove, and that being so he did not feel very talkative, though he might perhaps say a few words in reference to what had been said; in regard to lithography being used by artists at the present time as a means of placing their sketches before the public. He should like artists to look back to the time of Cattermole and others, for then lithography was used for finished work, and thus became the means of conveying the thoughtful products of thoughtful minds.

Mr. T. WAY, said although he was little more than an amateur, he had been connected with lithography for the last 50 years, during which time he had looked through all the different processes that had led up to the present success. He would recommend to every artist who wished to take up with lithography as a process of reproducing his works to study from the very beginning. The first thing to study was the stones. He had always found the question of stones to be one of the most difficult of all. The difference between two or three qualities of stones sent over from Germany to England gave some of the greatest difficulties that were met with in the treatment of lithographic drawings. What was known technically as the yellow stone was nothing to compare in quality with the hard grey stone, which it was now very difficult to obtain. It was only by accidentally meeting with an old stone which had been used over and over again from 1830 to the present time that they met with a stone which was perfect for fine drawing. In the granulation of the stone they met a great many varieties which should not be left entirely to the ordinary workman. It should be studied by the artist in order to see what was necessary for the reproduction of a real, perfect impression. It wes only by so doing that they could produce a really perfect drawing. He would appeal to the Chairman to support him in this statement. After the drawing was made it had to be put under a process of etching as it was called, and what was then wanted was practice and not theory in order to get it treated perfectly. In the process of printing every part of the technical printer was as necessary for the artist to study in order to produce a really perfect impression as the drawing itself of the picture on the stone or the paper. When you arrived at the stage of pulling the first impression you had to watch right through as carefully as Mr. Whistler would one of his own etchings in the press, because you had the power of distributing upon the stone the colour in different parts in the same manner in which you would have the finest etching upon copper-plate. Then again you had to watch the quality of the paper and the colour, to see whether it would sink deeply into the stone so as to take a fine impression, or whether it would only give a blurred impression.

Mr. CARL HENTSCHEL said his experience with lithography had been very slight, but his impression was that the reason why lithography had not been taken up to the extent that it might be was the fact that it required a far more skilful man to draw on prepared paper or stone, than it did in an ordinary way. The method of getting a successful result depended largely upon endeavouring to work by drawing on to the stone, but that had been avoided to a great extent now by drawing on ordinary lithographic paper. Some most successful results could be obtained by drawing on ordinary Scotch transfer paper. It was quite true, as the last speaker had pointed out, that the great difference existed in the quality of the stone and the grain. A large number of lithographs that had been well drawn on stone had been spoilt by the printer not knowing how to treat them. He had seen a large number of drawings done on stone which had been irretrievably spoilt by the printing in etching through using acids. His father always used an infusion of nutgall in the place of acids which gave fine delicate results, the points of the chalks not being lost as they were when acids were used. The acids had a tendency to destroy them. He did not think there were many debateable points in the paper.

Mr. COLEBROOKE said it was always important to use as short a word as possible, and he would therefore suggest to Mr. McCulloch that "papylith" might be used in place of the name suggested. At this very moment, in the lithographic press of New York, there was a rather significant article, which was apparently an indication of a movement going forward in New York for doing away with some of the rivalry between lithographic work and process work. This was an indication which might mean a good deal to those who were behind the scenes. He had been very much struck with the example of photo-lithography. He was of opinion that Senefelder foreshadowed everything of importance in connection with lithography, including the use of lithographic paper. He thought, in connection with the centenary of Senefelder, they should try to kindle a little enthusiasm. He felt rather sore at the comparative lack of interest which the public had taken in the centenary of Senefelder.

Mr. GLEESON WHITE said he was of opinion that the term "autolithography" had been used in a wrong sense in the paper. The word was invented (following the precedent of the painter-etchers) not to distinguish lithographs drawn on paper from those drawn on stone, but to differentiate the actual handiwork of the artist, whether on stone or paper, from drawings or pictures copied in lithography by other hands.

Mr. T. R. WAY said as Mr. McCulloch had spoken of Harding, Nash, and others, as producing works of the very highest kind, and they had suggested a form of work which should be developed at the present time by artists, he would like to call attention to three lithotints by Mr. Whistler which he thought were quite equal to anything that these other men had ever done. People did not quite realise Mr. Whistler's position in lithography. Sometime back he was talking to an artist about lithography, when he said it could not compare with etching, but he (Mr. Way) said he thought they had a master who had produced works in lithography quite equal to the masterpieces of Rembrandt in etching. Mr. Whistler had completely mastered the snbject, and carried it far beyond what others had done. There were three small drawings on the table of Mr. Whistler's, which were simply magnificent. Mr. McCulloch had wished to invent a new word to differentiate drawings done on paper from those done on stone, but he (Mr. Way) did not see any necessity for anything of the kind. The work of the artist came straight to the public. It did not pass through any process to get on to the stone. The artist's own strokes of chalk were on the stone, and they would come off on the print. In lithography they had so many means of expression that it was as well to say one was a stump drawing and one a line drawing, but both could be drawn either on stone or on transfer paper, therefore, there was no reason to multiply terms. The drawing would not last any longer if it were made on transfer paper. A drawing made for a photographic process remained intact, and could be reproduced dozens of times, but a drawing on stone if it was a deep drawing would last for some 100 prints or so, but if it were a delicate drawing it would only last for a small number of impressions. The fact of it being on paper gave it no longer life. The stone offered the greatest advantage to the artist, as he could work at it again and again, whereas the very nature of paper demanded that the work should be crisp and direct, and done without much fumbling. Although Mr. McCulloch was rather severe on Wilkie, he thought he was quite capable of doing the work in the drawing shown.

Mr. M. HANHART thought the reason why artistic lithography had such a lingering existence was on account of the small patronage it received. Etching was productive of a great deal of money, but those who produced artistic lithography received but a small recompense for so doing. Until lithography got out of this rut, there was but a very poor field before them. It was very gratifying to see that the subject was now being revived.

Mr. FISHER said he was sorry that no reference had been made by Mr. McCulloch to the works of Mr. Shannon, who was very eminent, though a young man in his profession. He would recommend the audience to endeavour to see the works of Mr. C. A. Shannon in the "Dial." This young man was now putting forth some splendid work, and it was unfortunate that none of his pictures were exhibited that evening.

Mr. WHISTLER said that having seen many of Mr. Shannon's works he could quite endorse the remarks of the last speaker.

The CHAIRMAN said, with regard to the comparison of lithography with etching as a mode of expression, he scarcely thought that was possible. Lithography was one mode of expression and etching was another; they were as different as water colours and oil colours, they were both beautiful. Mr. Way and Mr. Hentschel were most practical in their remarks, but he could not agree with Mr. Vincent Brooks that some people were not serious in their work. The word lithography, which had been invented by Senefelder, covered the whole process, and it was not necessary for them to have any other term. Mr. Colebrooke was quite right when he said that Senefelder did not discover photo-lithography, but he had invented every other method now in use save it, and all that had been done by others was to add and develop these methods. With regard to the centenary of Senefelder, he might mention that an exhibition had been held in Paris. There had been a private exhibition at Mr. Dunthorne's, and Mr. Whistler had also had an exhibition at the Fine Art Society, in addition to which there had been an historical exhibition in New York and Philadelphia, so that there were plenty of monuments to Senefelder. He did not see why artistic lithography had not been commercially successful. You could not breed lithographers any more than you could produce great painters. Those who did good work in the time of Cattermole did it because they loved the work. It was not any fault of his that there were no specimens of Mr. Shannon's exhibited that evening. In conclusion he proposed a hearty vote of thanks to Mr. McCulloch for his interesting lecture, and to Mr. Way for the magnificent collection of pictures and for his practical demonstration.

Mr. McCulloch, in reply, said he should be more than satisfied if anything he had said would induce people to cherish lithographs as they did etchings.

Mr. Way then briefly acknowledged the vote, and the meeting adjourned.

ELEVENTH ORDINARY MEETING.

Wednesday, Feb. 24, 1897; Captain W. de W. Abney, C.B., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society :—

Hine, George T., 35, Parliament-street, S.W.
Hunter, Surgeon-Major C.B., I.M.S., Chhindwara, Central Provinces, India.
Mansfield, Alfred, Messrs. P. Orr & Sons, Mount-road, Madras.
Verwey, Christinus, 17, Gracechurch-street, E.C.
Wilshire, Lewis W., 24, Strand-chambers, Derby.

The following candidates were balloted for and duly elected members of the Society :—

Barnett, Walter George, Great Indian Peninsular Railway, Sholapur, Deccan, India.
Grey, Arthur Ernest, 13, Spencer-street, Clerkenwell, E.C., and 20, Canonbury-villas, Canonbury-road, N.
Rex, Francis Herbert, 311, Kentish Town-rd., N.W.

The paper read was—

THE PRODUCTION OF COLOUR BY PHOTOGRAPHIC METHODS.

By Sir Henry Trueman Wood,
Secretary of the Society.

Although the main object which I have set myself in the preparation of this paper is the introduction to the Society of what I believe is the most promising process for the photographic reproduction of colour, I have thought that it would be more consonant with the Society's traditions, and more agreeable to those members who are present this evening, if instead of dealing merely with a single method and one at present, whatever its merits, as yet incomplete and almost untried, I endeavoured to submit to the Society a brief *résumé* of the whole question of colour-photography, to show the point which it has now reached, and to describe—or at least to summarise—the various methods for producing photographic pictures in colour which have achieved at all events some measure of success.

In attempting such a task I must apologise for the entirely inadequate treatment which must be given to inventions of exceeding merit and great ingenuity. Let me make this apology once for all, and let me excuse myself on the ground that I am about to try to compress into a single hour's discussion, a subject which would afford ample material for a course of Cantor lectures.

The "direct and permanent reproduction of the camera picture in its natural colours" has been described by an accomplished writer on the subject* as the greatest of all photographic problems. It has exercised the minds of photographers since the first discovery of the art. It was anticipated as a probable outcome of their researches by its earliest votaries, and though the advance of knowledge has only seemed to render its solution less and less likely, the hope of resolving it has never, I think, been quite abandoned, at all events by some enthusiastic spirits.

The tyro in photography can see no reason why if the camera picture can be reproduced in monochrome, it cannot also be reproduced in all its varied colours. An elementary knowledge of science supplies the reason. Photographic pictures are produced (experts will forgive my dealing for a few minutes with first principles) by the change effected by light falling on certain parts of a sensitive surface. The surface may be of various materials, and the change may be of various characters, but in every case such a change is produced that the altered parts of the surface will resist the action of some solvent which removes the unaltered portions. The action is too familiar to require specific illustration. I only desire to remind you that practical photography is merely a method of registering, by the greater or less density of the deposit produced, the greater or less intensity of the light incident on a given surface.

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* Professor Meldola, "The Chemistry of Photography," p. 321, edit. 1889.

What justification, therefore, have we for supposing that any improvement, any modification of such a process can produce a picture in colours? Consider the action which goes on when a negative is produced on an ordinary gelatine plate. An image—say of a landscape—is projected upon it by a lens. The light falling on the silver bromide produces some sort of change in it. What that change is, chemical or physical, we need not stay to inquire; authorities, as a matter of fact, are not agreed upon its nature, but that does not affect our argument. Suffice it to say that the altered bromide is more easily reduced by suitable chemical reagents than the unaltered. We pour on the plate such a reagent, the "developer," and the altered bromide is reduced (wholly or partly) to metallic silver. We then subject the plate to treatment by a solvent of silver bromide, the "fixing solution." The bromide is dissolved away and we have left an image in metallic silver following the lights and shades of the original, dense where the brightest light fell, clear where there was no action of light, with intermediate gradations in the intermediate shades.

The "negative" thus formed we place over a sheet of sensitised paper. The light passing through the clear portions blackens the silver salt on the paper, for here the change is a visible one, while under the shaded parts of the negative no change takes place.] Finally, the unaltered silver salts are dissolved away, and our picture is "fixed."

I have dwelt on these familiar details merely to impress on you the utter unsuitability of our present processes for producing pictures in colour, or anything beyond pictures in light and shade. So far as we know, all we have done is to throw down a more or less thick deposit of silver, which blocks out the light more or less effectively. It is difficult to regard this as even a first stage to the discovery of a process for reproducing the colours of Nature. For consider the conditions of the problem if it is to be worked out as a development of our present system. We should require, for the direct production of colour by light, not merely a substance sensitive to light, so that it can be brought by it into a soluble or insoluble condition (for that is what it amounts to), but a substance capable of having its structure so modified by light of different colours as to show permanently light of the same colour that caused the change, Further, when the desired change has been effected, the susceptibility to further change must be removed, or the picture would obviously be destroyed by the continued impact of light.

No such substance is known, nor is there any reason to believe that such a substance exists. Perhaps till it is discovered we may adjourn the consideration of such details as the manner of its treatment, or the light in which it is to be manipulated—just as the old alchemists adjourned the consideration of the material of which the vessel was to be constructed which might contain without dissolution the universal solvent, when it was discovered.

Such are the conditions of the problem, and it is not to be wondered at if those who were most competent to solve it have for long regarded it as insoluble.

The hope, however, of producing colour photographically was not abandoned till after a long series of researches had been made. Soon after the discovery by Scheele that chloride of silver was darkened by light, which was the foundation of all future photographic work, it was found by several experimenters that the different parts of the spectrum affected the chloride differently, and that the colours produced, to some extent, approximated to the colour of the part of the spectrum employed. This remark seems to have been first made by Senebier in 1782, and the observation was reported by Seebeck in 1810. This, as you know, was before the discovery of any practical photographic process. Thirty years later Sir John Herschel and Robert Hunt were working at the subject, and the former expressed the opinion in a communication to the British Association in 1841, that the experiments with which he was occupied might lead to the future production of naturally coloured photographs. Both Herschel and Hunt succeeded in producing on paper prepared with silver chloride and exposed first to diffused light, and then under coloured glasses, deposits of different colours reproducing more or less accurately the original colours of the glass.

A little later, in 1848, Edmond Becquerel took up this line of research, and succeeded in producing fairly vivid copies of the spectrum. He tried various methods; I believe the most successful results were produced on Daguerreotype plates, on which a film of silver chloride had been deposited by the use of a battery.

The plate was dried, heated, and exposed either to an image of the spectrum, or in the camera, and by these means actual reproductions of coloured objects were obtained. No method however was discovered of fixing these pictures, and they could only be viewed in a very subdued light, because the impact of light upon them of course continued the action and destroyed the picture.

Other experimenters, amongst them the late Mr. Warren de la Rue, have since continued this line of research, and pictures, similar I believe to those of Becquerel, were shown, in a darkened chamber, by Niepce de St. Victor in the Paris Exhibition of 1867. Still I do not think that any great advance has been made. It is not difficult to get either on silver chloride paper, or on a silver plate coated, by immersion in a solution of metallic chloride, with a film of silver chloride, variously coloured deposits of the chloride. A preliminary exposure to diffused light seems to be necessary. But how far these are accurate representations of the natural colours can be judged from the fact that the opinion has been expressed by a competent authority that the coincidence of colour is accidental.

I think it must be admitted that the process which, at all events theoretically, most nearly realises the idea of producing colours by the direct action of light, is that of Professor G. Lippmann. M. Lippmann, I believe, first exhibited photographs by his process in 1891. In 1894 they were shown in London by Mr. E. J. Wall at a lecture before the Affiliation of Photographic Societies, and they were again exhibited by M. Lippmann himself in 1896 before the Royal Society and the Royal Institution. Professor Lippmann has very kindly sent me, expressly for exhibition this evening, some examples of his work, which I am glad to be able to show you.

This most remarkable process depends on the phenomenon known as "interference." All of you know the colours which are shown by the film of a soap bubble. Most of you know the manner in which these are produced. Without going at length into a subject, a full explanation of which would easily take up the full time allotted for this paper, I may remind you that if white light falls on the surface of a film some of it will be reflected from the front surface, while some will pass into the film and be reflected from the back surface, the remainder passing through entirely. The waves reflected from the back surface will combine with those reflected from the front, and if the thickness of the film is such as to cause the rays of any particular wave length reflected from the back to be just half a wave length (or any multiple of half-wave lengths) behind those reflected from the front surface, the crests of one series will coincide with the depressions of the other series, they will interfere with and cancel one another.

If you are using mono-chromatic light—light of a single colour—the result will of course be the extinction of the light. If you are using white light—that containing all the colours of the spectrum—the result will be that certain of the waves are quenched and your reflected light will be white light minus those rays, that is to say, light showing colour.

This shows us that merely physical conditions may produce colour. It is simply a question of the thinness of the film, it does not matter of what the film is composed. It may be oil floating on water, or a stratum of air enclosed between two glass plates, or a deposit of oxide on a metallic surface, or a film of soapy water, it does not matter so long as it is of the right thinness.

Now if you can imagine a series of films superposed one upon another, or a layer of material composed of a laminated structure of this sort, it is not difficult to see that it should be, when illuminated by white light, capable of reflecting light of any colour, according to the size of the films.

Pray remember that I am not trying to explain the phenomenon completely. I am only trying to help you to realise the bare fact that colour effects can be produced by a purely mechanical device like that hinted at.

In treating of light-waves, their exceeding minuteness is such that the unpractised imagination finds it difficult to picture to itself the actions that go on. The difficulty is lessened if we educate our imagination with experiments on a larger scale. Let us consider a rough illustration of wave movement on a scale we can easily appreciate, an illustration M. Lippmann himself has used in explaining his invention. If you take a long cord, fix one end and jerk the other so as to send an impulse or wave along the cord, the wave will run to the fixed end and then be reflected back to your hand. If you keep sending a series of waves along the cord they will meet the series of reflected waves and the result will be that the cord will vibrate up and down in fixed lengths. "Standing waves" will be formed, with points, where the cord is stationary. Similar "standing waves" are produced in water when waves strike a vertical wall and are reflected from it. If such standing waves could be produced in light they would mean intervals of light and darkness, or in a sensitive medium, intervals of chemical action and no-action, the result of which would be a laminated or striated structure, which might be expected to reflect back light of the colour which created it.

I do not know whether Prof. Lippmann was the first to think out such a scheme. I believe he was anticipated by our distinguished countryman Lord Rayleigh, but he was the first to realise the idea in practice, and this is how he did it:—He placed a transparent sensitive film in immediate contact with a mirror, the mirror being composed of mercury. He found that light of any colour falling on the film passing through it and reflected back along the same line by the mercury mirror, produced in the film a series of strata, because there were points in the path of each ray of light where the waves cancelled and reinforced each other. Where they cancelled one another, there was no chemical action; where they reinforced one another, the chemical action was increased. Thus he obtained, by the action of light, the structure we have seen would be theoretically capable of showing, when illuminated by white light, light of the same colour as had produced it. That the theory should hold good for the infinitely complicated structure which must ensue when light of various colours is thus caused to act on the film, is hardly credible. But experiments proved the truth of his theories, and, after some time, M. Lippmann was able to produce not only an image of the solar spectrum, but also actual camera pictures from coloured objects, which, when illuminated by white light, gave back the colours of nature.

These pictures are of marvellous brilliancy and beauty. Unfortunately, they are by no means easy of production, nor are they capable of reproduction as ordinary photographs are. They can be seen by the naked eye, or better when illuminated by a powerful lantern and projected on a screen, but they are only visible as coloured pictures when viewed at a certain angle; looked at directly, or by transmitted light, they show no colour at all. For exhibition in the lantern, they are best seen when specially mounted, with a thin prism in front of them, in order to reflect away light falling on the surface of the glass, and to allow only those rays to reach the eye which are reflected from the surface of the picture itself.

Under these circumstances it is evident that while M. Lippmann's beautiful discovery must always be regarded as of the highest scientific interest and value, it is not, in its present state, likely to be turned to any practical account. What its future development may be, nobody can say. As a matter of fact, I believe not very many of the pictures have been made, and those chiefly by M. Lippmann himself, and by the brothers Lumière, who first succeeded in making gelatine plates sufficiently transparent for the purpose. M. Lippmann's first results were all obtained on films of collodion or albumen.

The difficulty of obtaining colour pictures by any direct process has led various inventors to try and discover methods by which the difficulty might be evaded. If several pictures could be taken, each showing the proper tone and gradation of one of the primary colour sensations, and these pictures could be combined into one, it is not unreasonable to expect that a picture with all the colours of nature would be the result. Such is the idea on which Mr. Ives has developed the very beautiful instrument which he calls the photochromoscope, an instrument which beyond any question gives us very vivid and beautiful representations of coloured objects. Mr. Ives has not been alone in his work, few inventors have, but as I believe he alone has succeeded in carrying his ideas into practical shape, I think the full credit of the invention is due to him, especially as he has always, in his published papers, shown the utmost readiness to admit the claims of other workers in the same field.

There is the less reason to describe his apparatus and method at length, inasmuch as he has already given full descriptions of it to the Society;* indeed, it was here that the invention was first introduced to an English audience. I may, therefore, content myself with saying that he takes three pictures of his subject, through three coloured glasses, red, green, and blue. He thus obtains a picture formed by the red, green, and blue (or rather blue-violet) rays of light. This picture, remember, is just an ordinary photographic negative taken by light of a particular colour. It has no colour of its own. If now we take a positive transparency from each negative, and illuminate it by its own proper light, we get what we may consider the red, green, or blue image, the

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See *Journal*, vol. xl. p. 687; vol. xli. p. 663; also "Camera Club Journal," February, 1897, p. 23.

version of the original we should get by looking at it through red, blue, or green glass. If, further, we combine these images together, we shall get the effect produced by looking at the original through white glass, that is the original with the colours of nature—always supposing our coloured glasses are so selected as to give, separately and in combination, the actual colours of nature. The photochromoscope is an instrument in which, by means of suitable reflectors and coloured glasses, this is done. The three monochrome pictures are each illuminated by its appropriate coloured light, and the three coloured images thus produced are reflected through a single lens, and form a single picture in the eye. By suitable modifications they can be projected by the optical lantern on a screen, and made visible to a large audience.

Another method for producing similar results has also been brought out by the same inventor. Having obtained his three positives as before—this time on films of gelatine or other suitable material—he dyes each film of a colour complementary to that by which the negative was taken, viz.:—lemon yellow complementary to the blue-violet, cyan-blue complementary to the red, and magenta-pink complementary to the green. He then superposes the films one upon the other. On viewing them by transmitted light we get a picture in all its proper colours. The reason for using complementary colours is obvious when we remember that we have here a case of absorption, whereas in the photochromoscope we have a mingling of coloured lights. If we look through blue and yellow glasses superimposed, we get green. If we combine the light passing through separate pieces of blue and yellow glass, we get white. This method has the advantage that it does not require a special apparatus for its exhibition, but I understand there are certain difficulties in carrying it out practically which prevent its becoming as useful as it is certainly promising. At all events, Mr. Ives himself seems to prefer the more complicated method I have previously described.

Mr. Ives has lent me, for use this evening, one of his ingenious triple lanterns, by means of which I am able to show, projected on the screen some of his three-colour slides, and he has also enabled me to show you examples of his three-film slides, so that you can judge for yourselves of the vivid accuracy with which they reproduce the colours of nature.

A very ingenious method has been proposed for printing the three colours on a single film. This depends on the fact, discovered by Messrs. Cross, Bevan and Green, that certain of the coal-tar colours are sensitive to light.* When a fabric, stained with one of these "diazo-derivatives," is exposed under a positive transparency, the parts acted on by light lose their power of combining with certain colouring matters (naphthols, phenols, &c.) and remain unchanged, while the shaded parts are dyed, the colour depending on the particular reagent employed. To produce a coloured transparency from three negatives, first, the blue-printing negative is printed in a blue colour (to obtain this, the ferro-prussiate process is used, the diazo-compounds not giving a good blue), then the film is treated with the diazo mixture for producing red, and a print taken from the "red" negative. This combined print is again sensitised with the mixture for producing yellow, and a print from the "yellow" negative taken. The result is said to be a positive in natural colours. Three negatives are required, and three printings, but only one film. One defect in the process is stated to be that the prints fade when used in the lantern, and this is likely to be the case, for the coal-tar colours (or, at least, some of them) bleach very rapidly in a strong light.

An obvious objection to Mr. Ives's process is the necessity for using three separate pictures. Dr. Joly and some other inventors have endeavoured to get over this objection by using a single variously coloured screen composed of fine coloured lines, taking the picture through that, and backing up the finished positive with a similar screen. One would hardly have expected good results from such a process, and yet it does give very fair results. The effect of colour is well produced, but the picture itself shows the grating, and suggests rather a print from a coarse process block than a direct photograph. I have not, however, had an opportunity of seeing many examples, and I believe very few have been publicly exhibited.

We now come to what is, I think, the latest development of colour-photography — the very interesting process of Mons. Villedieu Chassagne, a process which a fortunate accident some time ago brought to my notice, and one which is, I think, of sufficient importance to justify its being brought before the Society even in its present stage.

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* Mr. Cross and his colleagues described the process in a paper read before the Society in January, 1891 (*Journal*, vol. xxxix. p. 150). Mr. Bothamley gave an account of this three-colour printing process, in *Photography*, June 4, 1896. According to his statement, it was devised by Messrs. Lumière and Seyewitz.

The actual inventor of the process, I am told, was Dr. Adrien Michel Dansac, and it was worked out jointly by him and by Mons. Chassagne; but the illness of the former incapacitated him from pursuing his researches, and the matter was left in Mons. Chassagne's hands alone.

There is this difficulty in the scientific discussion of the subject, that the process is in part a secret one, and it is impossible to regard it with quite the same interest as a process which one can follow out from beginning to end, as was the case with those other methods with the consideration of which we have previously been occupied this evening. Nevertheless, you will understand that I do not think that we have any reason to complain of an inventor who quite reasonably retains in his own hands the secret of his invention in order that he may reap from it his perfectly fair and legitimate profits. But, if we admit the inventor's right to reticence, he must admit ours to suspended judgment. He must be content to submit to the severest examination and cross-examination. He must not expect to have any of his statements accepted until they have been verified by independent evidence or supported by independent testimony. Let me add that there is a special difficulty in the way of a honest inventor in this particular subject, because so many pretentious schemes for the production of photographs in colour have been at different times foisted upon the public.

It is a matter for sincere regret that the publication of scientific advances should so often be hindered by commercial considerations. But we cannot help this. We must take things as we find them, and it would, I think, be foolish of us to refnse to avail ourselves of limited information because full information is withheld.

Regarding the matter in this light, I have very much satisfaction in being able to bring before the Society a process of extreme interest and great promise, and I do not hesitate to express the opinion that on the whole we ought to feel ourselves greatly indebted to Mons. Chassagne for letting us even as far as he has into his secrets. Few inventors are so liberal as he has been, and I hope it may not be long before he may be in a position to disclose the whole of his process, and give photographers the opportunity of working it out thoroughly for themselves.

The process, so far as we know it, is as follows:—A negative is taken on an ordinary gelatine plate, which has been prepared by treatment with a solution, the ingredients of which are unknown. The negative thus obtained shows no trace of colour, and appears in all respects like any other photographic negative. From it a print is taken on ordinary albumenised silver paper, which has been treated with the before-mentioned solution; or if a transparency is desired, on a gelatine plate prepared in the same manner as that which was used for the negative. This print shows no trace of colour either by reflected or transmitted light. The print when dry is washed over with the solution, and is afterwards treated successively with three coloured solutions—blue, green, and red—the operation being conducted in a bright light. As the solutions are applied the print gradually takes up its appropriate colours, the intermediate tints being, it is supposed, produced by a mixture or combination of the three primaries. That a yellow colour should be produced by a combination of what are presumably green and red pigments is not in accordance with expectation, for though red light and green light when superimposed produce yellow, we do not get yellow by mixing red and green colouring matters. Probably the yellow is produced by the application of a yellow dye mixed in the green solution, and not by a combination of colours.

It is to be noted that the process is not one for the direct reproduction of natural colours. It is rather one for treating a photographic print in such a way that it enables it, one might say, to automatically paint itself, to take up in the proper parts the colours which are required, rejecting them in the parts where they are not required. How this is effected is at present a mystery, and perhaps with the limited amount of information available it is not worth while speculating upon it. How a monochrome negative can confer on a monochrome print this power of selective absorption has yet to be explained. I can offer no suggestion on the subject. I am informed that a negative of a special character is required to produce the coloured positives, and that is all I know about it.

The results certainly are produced, and there seems no reason to doubt the good faith of those who state they were produced in the manner described. Of course when we are thus asked to accept facts without receiving an explanation of them, we require as I said before very strong evidence that the facts are genuine. Examination and experiment, so far as they have yet gone, have thrown no doubt on the statements made, and the inventor, I wish to say most distinctly, has offered every facility for inspection so long as the secret of his materials is respected. Sufficient time has not elapsed for crucial tests to be made, but we may reasonably expect that the process will stand those tests as well as it has those to which it has been submitted.

I have myself seen the colours applied in the way I have described, and the promised results produced. Mr. Herbert Jackson and myself took negatives on Mons. Chassagne's plates of various test objects. Mr. Jackson was afterwards kind enough to make some positives from these plates, and neither negative nor positive was touched, or I think seen, by Mons. Chassagne, until we placed them in his hands that they might receive their final treatment. On the application of the colouring solutions, we saw that the proper colours were produced.

Photographically, the results we obtained were very poor; the prints were extremely thin and unsatisfactory, as was not to be wondered at, since the negatives were taken on a dull foggy day. Nevertheless they showed a great deal more than traces of the proper colours. A blue china vase, with a piece of red ribbon tied round it, and containing a bunch of flowers, was reproduced with perfect accuracy, though the image was thin and faint. An Indian brass pot showed not only the yellow colour of the brass, but also distinctly metallic lustre. Altogether I can only say that the results of these experiments, so far as they went, satisfied myself, and I think the others who saw them, that the results were produced in the manner described. Were it not for the novelty of the process, and the difficulty of accounting for its results, it would be accepted without hesitation. Whatever hesitation exists is after all but a testimony to its importance.

I have been taken to task, by some of my friends, for accepting results so remarkable without evidence more substantial. I can only say that I think any of you who saw the process carried out would have arrived at the conclusions at which I arrived. All evidence is a contest of opposite improbabilities. It seemed to me more probable that the colours were produced in the manner stated than that the prints were first painted by hand, then bleached, and then the colours restored under my eyes, by the application of some mordant; or that the operator who seemed to be sluicing and dabbing his colour all over the print, was really painting it on in the proper places. I can think of no other alternative. Still I freely admit I shall myself like to know more about the method. I look forward shortly to being supplied with the materials, and I shall not be absolutely happy until I have myself produced something which—however inferior it may be to the very beautiful examples we have here to-night—shall yet show the colours of an original subject taken by myself.

In a secret process such as this it does not seem worth while to speculate. First, because it is a waste of time guessing how results are produced that we may expect to have fully described to us in a short time; and, secondly, because it does not seem fair to use information published by an inventor, for the purpose of finding out the nature of his invention and robbing him of the reward of his work.

I should like, however, to draw your attention to some more or less recent researches which indicate what has been done by workers in the same field, since they may help us to realise what probability there is of success being attained by this, or some similar process.

All I think are based on the process of Becquerel, to which I referred in an earlier part of this paper. Now very much depends on the manner in which the colour of the Becquerel films is produced; whether they are pigmentary or interference colours. If the latter is the case, the only hope for success is on the track which has been so successfully followed by M. Lippmann. If the former, there may be some hope by chemical treatment of so developing or reinforcing the colours as to produce results such as those we have seen this evening.

In an elaborate paper by Otto Wiener, to which my friend Mr. Bolas has drawn my attention, a method is suggested for distinguishing between interference colours and actual pigmentary colours, depending on the fact that interference colours change with the angle of view, while pigmentary colours do not. When tested by this method it was found that colours obtained by Becquerel's method on chlorinised silver plates were due in the main to interference, but that when chloride of silver in a flocculent mass was used the colouration was pigmentary in its nature, and the same colour was observed by reflected or transmitted light.

Up to the present no explanation has been offered why any coloured compound should correspond to the rays which produced it. But Wiener somewhat boldly hazards the theory that there is a potentiality of producing various coloured bodies in the action of light. He suggests that any given colour tends to survive under a radiation correspondng to itself, because it best reflects that radiation, absorbing it least, and being therefore east affected by it. In fact he lays it down as a probable general law, that coloured illumnation acting on suitable material generates pigmentary bodies of corresponding colours. The theory is interesting, and would answer many questions if it could be substantiated, but at present I know of no evidence by which t can be supported.

The chemical treatment of the Becquerel ilm has been attempted by very many. Success has been frequently announced, but very arely attained. The most recent publication on the subject is contained in a paper brought by Mons. A. Graby before the Paris Academy of Sciences, an abstract of which, translated rom the Comptes Rendus, appeared in the "Photogram" for the current month. An xposure is made on the surface of silver hloride in contact with various re-agents. So ar as can be gathered from the abstract, it ppears to be assumed that red, blue, and yellow subchlorides of silver exist in the film, r are produced in it by the preliminary exposure which is made before the exposure to the coloured image. The author appears to rgue that the coloured chlorides are preserved in light of their own colour, and are destroyed, r converted, by light of another colour acting n them in the presence of the re-agents speced. That chloride of silver can be obtained in a condition showing strong colours we know rom the researches of Carey Lea in 1887, researches which attracted a great deal of attenon at the time, but have not borne much fruit nce.

In the year mentioned, he announced that the aloid salts of silver (chloride, bromide, and odide) could be obtained, by chemical treatment, of various colours, red, purple, and lue. Whether these "photo-salts," as Carey ea termed them, are definite chemical compounds, or whether they are not of the ature of "lakes" (organic colouring matters precipitated in the presence of a metallic base, generally alumina) "physical combinations of unaltered haloid with the reduction product" (Meldola) is, I believe, still an unsettled question. If these photo-salts are of this character, and if they have the power of combining with colouring matters of their own hue, and if again a process for practically utilising these properties can be worked out, it is conceivable that pictures such as Becquerel produced might be turned into permanent coloured pictures. This, indeed, is mere speculation, and rather crude speculation, for it assumes a very great deal more than we have any right to assume.

At all events, we know that a certain amount of colour can be produced on films of silver chloride, and it is at least conceivable that the condition to which the chloride is brought when it shows colour, is also a condition which enables it to combine with colouring matters, though at present I do not know of a particle of evidence, apart from the evidence afforded by the pictures we have before us this evening, to justify such a proposition. However, we have much to learn on the subject of colour, and I believe M. Chassagne's invention will open up a fresh field for research to those who, like our Chairman, have added so much to our knowledge of photographic theory. I hope that Captain Abney will investigate the problem for us, and that before long he may give us a full and consistent theory of the whole subject. When he does, he will, I imagine, have added a good deal to our knowledge, not only of photography, but of the science of colour.

That the process is capable of very considerable development, I think, can hardly admit of much doubt. The colours in themselves are capable of much improvement. The merits of the productions, you can, however, estimate for yourselves from an inspection of the very large number of examples, which, by M. Chassagne's courtesy, I am able to show you this evening. The great bulk of them have been prepared during the past three weeks for the illustration of this paper, so that it is evident they can be produced rapidly, and I am informed that their actual cost is very moderate. I think, therefore, that we have here a process, even in its present condition, of considerable practical value, and one capable of producing results more likely to be turned to practical account than any other which I have seen.

The last things I have to show you this evening are some photographs in colour produced by Mr. Bennetto, of Newquay in Cornwall.

Mr. Bennetto has not yet published his process, but he has kindly undertaken to show some of his results this evening, I must allow them to speak entirely for themselves, but I am sure you will agree with me that we are greatly indebted to Mr. Bennetto for showing us the pictures; and, personally, I feel very much obliged to him for enabling me to make this communication as complete as it is by the inclusion of at all events, a reference to what, however they may be produced, are, without any question, among the very latest attempts to solve the problem of obtaining photographs in colours.

The following illustrations were exhibited in the Meeting-room and Library:—

Collection of prints and transparencies by the Chassagne process.

Specimens showing the various stages of the Chassagne process.

The Ives photochromoscope.

Ives' three-film slides and triple lantern slides. (Shown on the screen.)

Lippmann's interference photographs. (Shown on the screen.)

Lantern slides by Mr. Bennetto. (Shown on the screen.)

Specimens of photographs in colour by Mr. Arthur Jane.

Example of colour printing—Woodbury film on chromolithographic backing—lent by Mr. T. Bolas.

Illustrations of three-colour printing processes, lent by Mr. L. Warnerke and Mr. T. Bolas.

Specimens of Crystoleum, executed and lent by Mrs. P. H. Kirkaldy.

DISCUSSION.

The **CHAIRMAN** said Sir Henry Wood had given such an excellent account of the different processes he had referred to, that it would be idle to attempt to enlarge upon it, and though, if he were to be hypercritical, he might find one or two remarks with which he did not quite agree, he must say that the general scope of his paper commended itself to him entirely. One or two more names might, perhaps, have been mentioned in connection with colour photography; in particular, that of the late editor of the *Photographic News*, Mr. George W. Simpson, who devoted himself for a considerable time to the investigation of the colours produced on chloride of silver, in what was known as Simpsontype. Very many remarkable experiments had been made with chloride of silver, not only by the ordinary photographic printing process, but investigating it in what he might call a more brutal way, giving it plenty of exposure so as to get the germs of the chloride pigments which no doubt existed. He had always held, and still held, that there would be no photography in natural colours until they were produced by light as pigments. Lippmann's photographs were not really photographs in natural colours, because they were only visible at one angle, or approximately so; a photograph in natural colours must be one in pigments. The question was, had those pigments been produced? and the answer was that they had, many years ago, almost at the dawn of photography, when Becquerel produced his photographs on chlorinised silver plates. A paper had been alluded to by Otto Wiener, in which it was said that these were not pigment colours, and, of course, they were not entirely so—some were produced by interference, the same as Lipmann's; but when you could get on a sheet of glass the colours you got by Becquerel's process, and you had the same colours by transmitted and by reflected light, a large proportion at least of the colours must be pigment and not due to interference. It was not quite correct, therefore, to say that photographs in natural colours had never been produced; the great crux was, could those natural colours be rendered permanent by fixing. If anyone had discovered a method by which the photographs produced by Becquerel could have been rendered permanent, photography in natural colours would have been a commercial fact long ago. Niepce produced not only photographs of the spectrum (which was quite easy with sunlight; in two minutes you could produce one as brilliant as the one shown on the screen), but Niepce and St. Victor produced a number of photographs, which were sent to London by his widow after his death, and which he (the Chairman) had the opportunity of seeing, pictures of dolls of various kinds, which were all in natural colours, but would not bear exposure to daylight without fading away. Coming next to Mr. Ives, not everyone in the room might be aware of his opinion of that gentleman's process. It was the acme of perfection, showing what could be done if you took the trouble to use three plates in a scientific manner. Mr. Ives was a competent experimenter and a deep thinker, and he had practically applied scientific theory. One of the lessons which ought to be taken to heart was—that although the scientific man with his theories might be scoffed at for a time, eventually some one, like Mr. Ives, came forward and showed how theory could be applied to practical work. Another process referred to was that of Professor Joly, which was a very remarkable one indeed, and was practically founded on the fact that the eye was unable to distinguish two colours when they were separated by a very small interval, so that when two dots or lines, red and green, were very close together they appeared as one dot or line of yellow. He had had the pleasure of seeing those photographs at the Royal Society and elsewhere, and although they were not then perfect, they had, no doubt, since been improved. He thought the process had the germs of success in the future. With regard to the Chassagne process, it had been truly said by Sir Henry

Wood that an inventor who kept his method secret had to prove his case up to the hilt. He had been fortunate enough to see the process, and certainly everything he saw was above board; there was no "faking" of any kind. What was to be seen was perfectly true, what was done was perfectly effective, and the colours in an object were reproduced in the print. How they were reproduced he could not say. They had yet to know whether the negative was responsible for the colours or whether it was the print alone. Whether it was an happy accident to make those particular dyes take on particular parts of the photo or not, had still to be learned; but, whatever the reason, the fact remained that the colours were produced in proper order and in the proper places on the print, and without any brush manipulation, because one saw a brown and white print manipulated in a very free and easy way, and wherever the blue ought to be, there the blue was, and the same with green, flesh tints, and all the other colours. Whether it was going to be a commercial success he did not know or care; what he wanted to know was, how these things happened, and he hoped before long they would have the opportunity of further investigation, and of finding out how much depended on the negative, and how much on the printing. It was also a great pleasure to him to see the photographs of Mr. Bennetto; he had heard a good deal of his work, and gathered it was something of the character that had been shown, but was not prepared to find quite such brilliant colouring. He was equally anxious to investigate that process, as he was that of M. Chassagne.

The CHAIRMAN proposed a vote of thanks to Sir Henry Wood, which was carried unanimously.

In acknowledging the vote of thanks, Sir HENRY WOOD said, that the thanks were due not to him but to those who had so generously lent the admirable collection of examples which he had been able to exhibit — Professor Lippmann, Mr. Ives, Mons. Chassagne, and Mr. Bennetto. He also wished to express his indebtedness to Mr. Davenport, who had taken an immense amount of trouble in making the rather elaborate arrangements necessary for the proper exhibition of pictures.

Obituary.

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SENATOR FERRARIS, D.Sc.—Galileo Ferraris, the distinguished Professor of Electricity at the Royal Italian Industrial Museum of Turin, died after a short illness on the 7th inst. He was born at Livorno Vercellese (Province of Novara) in 1847, and after obtaining the diploma of Civil Engineer he entered the Industrial Museum of Turin twenty-six years ago as an assistant to the Professor of Physics. In 1879 he was appointed full professor. Professor Ferraris devoted so large a portion of his course to Electricity that it was thought advisable to found a special professorship of electricity, to which he was appointed. In connection with this he formed a laboratory filled with the choicest apparatus, and to meet the requirements of the large number of students, he started a special school of Electro Technology at the Industrial Museum. Professor Ferraris was the author of many important papers, and was connected with most of the great Electrical Exhibitions. In 1896 he was appointed a Senator, and in the same year he was elected an Honorary Corresponding Member of the Society of Arts.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

MARCH 3.—"English Orchards."—By GEORGE GORDON. W. T. THISELTON DYER, C.M.G., F.R.S., Director of Kew Gardens, will preside.

MARCH 10.—"The Prevention of Fires due to the Leakage of Electricity." By FREDERICK BATHURST. W. H. PREECE, C.B., F.R.S., will preside.

MARCH 17.—"Music in England at the Queen's Accession." By J. SPENCER CURWEN. SIR WM. CLEAVER FRANCIS ROBINSON, G.C.M.G., will preside.

MARCH 24.—"The Transmission of Power by Alternating Electric Currents." By W. B. ESSON, M.Inst.C.E.

MARCH 31.—"Cycling—Historical and Practical." By GEORGE LACY HILLIER.

APRIL 7.—"Dairy Produce and Milk Supply." By M. J. DUNSTAN, M.A., F.R.S.E. The RIGHT LORD BELPER in the chair.

INDIAN SECTION.

MARCH 11, at 4.30 p.m.—"Prevention of Famine in India." By SIR CHARLES ALFRED ELLIOTT, K.C.S.I. (Secretary to the Famine Commission of 1878, and late Lieutenant-Governor of Bengal). The Rt. Hon. LORD GEORGE HAMILTON, M.P., Secretary of State for India, will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

MARCH 16.—"The Progress of the British Colonies of Australasia during the Sixty Years of Her Majesty's Reign." By JAMES BONWICK.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock:—

MARCH 2.—"Gesso." By MATTHEW WEBB. HUGH STANNUS, F.R.I.B.A., will preside.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

C. F. CROSS, "The Industrial Uses of Cellulose." Three Lectures.

MARCH 1.—LECTURE III.—The chemical industries in cellulose compounds—Viscose and viscoid: production and applications — The spinning of "nitro-cellulose" and production of lustra cellulose (artificial silk)—Smokeless powders from structureless celluloses—Cellulose acetates: production and application.

HOWARD LECTURES.

Thursday Evenings, at Eight o'clock :—

PROF. JAMES A. EWING, M.A., F.R.S., "The Mechanical Production of Cold." Six Lectures.

MARCH 4.—LECTURE VI.—The production of very low temperatures—Liquefaction of "permanent" gases—Compound cycles—Method of Linde and Dewar—Linde's process of producing oxygen by liquefying air—Recent low-temperature research.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 1...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. C. F. Cross, "The Industrial Uses of Cellulose." (Lecture III.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. Arthur W. Sutton, "Potatoes."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. Arthur Newsholme, "Nature of Nuisances, including Nuisances the Abatement of which is Difficult."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. J. W. Lovibond, "Relation of Colour to Quality in Malt." 2. Mr. J. H. Jenkins, "Hehner's Bromine Tests for Oils." 3. Mr. J. H. Coste, "Note on the Analysis of Superphosphates."

British Architects, 9, Conduit-street, W., 8 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Prof. Marloskie, "The Relations of Science and Faith."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. H. Lewis Jones, "The History of Röentgen's X Rays and their Practical Applications."

Medical and Chirurgical, 20, Hanover-square, W., 5 p.m.

TUESDAY, MARCH 2. ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Mathew Webb, "Gesso."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. D. Waller, "Animal Electricity." (Lecture VII.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Self-Propelled Traffic Association, Colquitt-street, Liverpool, 8 p.m. Mr. Dugald Clerk, "Oil Engines for Motor Vehicles."

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. H. M. Wallis, "The Growth of Hair upon the Human Ear, and its Testimony to the Shape, Size, and Position of the Ancestral Organ." 2. Mr. Gambier Bolton, "Notes on a Visit to the Bird Islands, Saldahna Bay, South Africa." Illustrated with Photographs from Life shown by Lime-light. 3. Mr. F. E. Beddard, "A Collection of Earthworms from South Africa, belonging to the Genus *Acanthodrilus*."

WEDNESDAY, MARCH 3...SOCIETY OF ARTS, John-street, Adelphi, S.W., 8 p.m. George Gordon, "English Orchards."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. 1. Discussion of Mr. Hardingham's Paper, "The Amendment of Patent Specifications." 2. Mr. A. P. Jones, "Some Notes on a Bill relating to Trade-marks, prepared by the London Chamber of Commerce."

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, MARCH 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Howard Lectures.) Professor James A. Ewing, "The Mechanical Production of Cold." (Lecture VI.)

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. W. G. P. Ellis, "A Trichoderma Parasitic on *Pellia epiphylla*, Corda." 2. Dr. W. B. Benham, "New Species of Perichæta from New Britain."

Chemical Society, Burlington-house, 8 p.m. 1. Dr. Sydney Young and Mr. G. L. Thomas, "Normal Iso-pentane." 2. Dr. Sydney Young, "The Vapour Pressures, Specific Volumes, and Critical Constants of Normal Pentane, with a Note on the Critical Point." 3. Mr. C. T. Heycock and Mr. F. H. Neville, "The Freezing-point Curves of Alloys containing Zinc." 4. Mr. A. H. McConnell and Mr. E. S. Hanes, "The Oxides of Cobalt and the Cobaltites." 5. Ballot for Fellows.

London Institution, Finsbury-circus, E.C., 6 p.m. Rev. Canon Benham, "Cheapside."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. F. H. Evans, "Canterbury and Ely Cathedrals."

Royal Institution, Albemarle-street, W., 3 p.m., Prof. P. Gardner, "Greek History and Extinct Monuments."

Camera Club, Charing-cross-road, W.C., 8½ p.m. Lecture by Captain Abney.

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. J. F. J. Sykes, "Objects and Methods of Inspection."

FRIDAY, MARCH 5...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. Shelford Bidwell, "Some Curiosities of Vision."

Geologists' Association, University College, W.C., 8 p.m. Professor Henry A. Miers, "Some Properties of Precious Stones."

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m.

SATURDAY, MARCH 6...Royal Institution, Albemarle-street, 3 p.m. Lord Rayleigh, "Electricity and Electrical Vibrations." (Lecture I.)

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FRIDAY, MARCH 5, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Mr. C. F. Cross, F.C.S., delivered the third and last lecture of his course on "The Industrial Uses of Cellulose," on Monday evening, 1st inst.

On the motion of the Chairman, a cordial vote of thanks to the lecturer for his course was passed.

The lectures will be printed in the *Journal* during the summer recess.

HOWARD LECTURES.

On Thursday evening, 25th February, Professor James A. Ewing, M.A., F.R.S., delivered the fifth lecture of his course on "The Mechanical Production of Cold."

The lectures will be printed in the *Journal* during the summer recess.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1897 early in May next, and they, therefore, invite members of the Society to forward to the Secretary, on or before the 10th of April, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit for promoting Arts, Manufactnres, or Commerce," and has been awarded as follows in previous years :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great services to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Michael Faraday, D.C.L., F.R.S., "for discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S., "for the invention and manufacture of instruments of measurement and uniform standards by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I., "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the Department of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., late Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the applications of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong (now Lord Armstrong), C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson (now Lord Kelvin), LL.D., D.C.L., F.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce, by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science to industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labour in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silk worms and domestic animals, whereby the arts of wine-making, silk production, and agriculture have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and as Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of the several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communications of North America, and have thereby rendered valuable aid to the commerce of the world."

In 1885, to Mr. (now Sir) Henry Doulton, "in recognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Samuel Cunliffe Lister (now Lord Masham), "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry—the utilisation of waste silk."

In 1887, to HER MAJESTY THE QUEEN, "in commemoration of the progress of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of her reign."

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S., "in recognition of the value of his researches in various branches of science and of their practical results upon music, painting, and the useful arts."

In 1889, to John Percy, LL.D., F.R.S., "for his achievements in promoting the Arts, Manufactures, and Commerce, through the world-wide influence which his researches and writings have had upon the progress of the science and practice of metallurgy."

In 1890, to William Henry Perkin, F.R.S., "for his discovery of the method of obtaining colouring matter from coal tar, a discovery which led to the establishment of a new and important industry, and to the utilisation of large quantities of a previously worthless material."

In 1891, to Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., "in recognition of the manner in which he has promoted several important classes of the Arts and Manufactures, by the application of Chemical Science, and especially by his researches in the manufacture of iron and of steel; and also in acknowledgment of the great services he has rendered to the State in the provision of improved war material, and as Chemist to the War Department."

In 1892, to Thomas Alva Edison, "in recognition of the merits of his numerous and valuable inventions, especially his improvements in telegraphy, in telephony, and in electric lighting, and for his discovery of a means of reproducing vocal sounds by the phonograph."

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S., "for thei joint services to scientific agriculture, and notably fo the researches which, throughout a period of fift years, have been carried on by them at the Experimental Farm, Rothamsted."

In 1894, to Sir Joseph (now Lord) Lister, F.R.S. "for the discovery and establishment of the antisepti method of treating wounds and injuries by which no only has the art of surgery been generally promoted and human life saved in all parts of the world, bu extensive industries have been created for the suppl of materials required for carrying the treatment int effect."

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S. "in recognition of the services he has rendered t

Arts, Manufactures, and Commerce by his metallurgical researches and the resulting development of the iron and steel industries."

In 1896, to Prof. David Edward Hughes, F.R.S., "in recognition of the services he has rendered to Arts, Manufactures, and Commerce, by his numerous inventions in electricity and magnetism, especially the printing telegraph and the microphone."

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, Feb. 16, 1897; The MARQUIS OF LORNE, K.T., in the chair.

The CHAIRMAN said he thought it was an unnecessary ceremony to introduce Mr. Colmer to a London audience. Mr. Colmer had been Deputy-Commissioner of Canada for very many years in London, and it was well known to all who came from the other side with what courtesy he had always attended to their wants, and latterly he had been particularly distinguished by writing a most able essay upon Imperial connection. In that essay, which obtained the prize last year given by the *Statist* newspaper, Mr. Colmer put forward views which deserved the very serious consideration of the British public. It was all very well for those in England, who had made the country full of manufactories, to think that the whole world must model themselves upon the model of free trade. They could not shut their eyes to the fact that the rising Anglo-Saxon nations over the water could not take exactly the same view as they did. It was, therefore, of supreme importance that if they were to maintain a good understanding with the colonies, and thoroughly understand their wants and wishes, that those views should be laid prominently before the British public, who did not go always exactly upon the lines of what had been called Cobden Club doctrines—not that Cobden was so extreme a free-trader as many of those who belonged to the club. If great and powerful colonies desired that a moderate revenue should be raised upon certain articles, this was at all events a proposal that ought to be considered, and Mr. Colmer in the essay which he had placed before the British public had elaborated a plan by which, without deteriorating to any great extent the British Revenue, they might please the colonies by giving them a preference as against a foreigner. It was probable that these views would not find acceptance for a good number of years, but it was certainly high time that they should be considered. The time might very soon come when some colony would ask England, in view of international arrangements, to favour them against a foreigner in some comparatively small way, and they should be prepared when that time came, to see whether it was possible to grant the request with a view to the perfect understanding which was so necessary for the British public in the time of trouble and war. Mr. Colmer in his own person illustrated another great virtue of the Canadian people; that was, they had found themselves able to keep aloof from the great fault which was so noticeable in the United States Government, and against which every President had protested, namely, the practice of extracting the spoils of office whenever a new Government came into being. In Mr. Colmer they had a living proof that in Canada the spoils of office system did not prevail, because he had lived officially through the recent change of government in Canada, and long might he adorn the office which he had so well filled. The High Commissioner for Canada was another living example of the same virtue; although he did not belong to the party which formed the present federal Government of Canada, yet he also had been retained in office. In that they must recognise the Conservative instinct—using the word "Conservative" not in a party sense—of the Canadian people whose practice in politics had been as steady and as certain as their excellent climate. You might depend upon the action of the loyal Canadian people as much as you could upon the recurring seasons of summer and winter throughout that glorious country. The Canadians had shown what power of progress they possessed; they had done that which Australia had been unable to accomplish. In spite of being scattered in different colonies more widely separated than the Australian colonies, and less in touch with each other, they had been able to surmount the difficulties of distance and race, and to form a great confederation as well as to build up a strong British power on the American continent. This was done not in a time of fear or pressure from foreign foe, but gradually and determinedly, and as everyone hoped and believed successfully for all time. Mr. Colmer would no doubt go over the time which had elapsed since the Queen came to the throne, and would point out the chief points on which the great Canadian Dominion had progressed during the last fifty or sixty years.

The paper read was—

THE PROGRESS OF CANADA DURING THE SIXTY YEARS OF HER MAJESTY'S REIGN.

By J. G. COLMER.

The arrangement of a series of papers on the progress of the British Colonial Empire during the sixty years of her Majesty's reign, to be read before the Foreign and Colonial Section of the Society of Arts, will generally be regarded as a happy inspiration on the part of the Committee. Many of you will have listened to or read the very interesting paper by Sir Charles Dilke on the general question a few weeks since. I feel it an honour that the paper on Canada should have been entrusted to me, and that a gentleman so much esteemed in Canada as the Marquis of Lorne should preside on the occasion. Although the large majority of Canadians have never seen her Majesty, they have had visits—not so frequent as they would have liked—from her sons and daughters and grandchildren. They retain a grateful recollection of the kindness and consideration of H.R.H. the Princess Louise during those years when the Marquis of Lorne filled so successfully the position of Governor-General. The title of this paper forms a text upon which a dozen lectures might be based, and it is not easy to compress within about sixty minutes—that is a year a minute—a record of events to which several hours might profitably be given. What I propose to do is to devote the time at my disposal to a short description (1) of Canada as it was, (2) of some of the prominent events in the last sixty years, and (3) of Canada as it is to-day.

In 1837, when her Majesty ascended the throne, there was no Dominion of Canada. British North America comprised the provinces of Nova Scotia, Prince Edward Island, New Brunswick, Lower Canada and Upper Canada. They were separate and distinct provinces, and treated one another almost as independent communities. There was little or no communication between them, except by water. In the summer time, during the season of navigation, steamboats plied between Quebec and Montreal, and the Maritime provinces. There were steamboats also between the different rapids from Montreal to Kingston, the passengers being conveyed over the portages by stage, or having to go on foot. That was before the St. Lawrence canals were improved, or indeed many of them constructed. From Kingston regular steamboats passed to Toronto and Hamilton. There was a main road between Quebec and Windsor, at the western end of Upper Canada, a distance of nearly 700 miles. It largely followed the rivers and lakes, and was the main artery of communication by land. It was known as the Front. Roads branched off here and there to the settlements in the interior. There was also trails through the forest to the less important places. When the roads were good enough stage coaches were used, but there were no macadamised roads in those days, and much of the travel was carried on by means of lumber wagons—that is during the spring, summer, and autumn months. In winter sledges were of course employed, wheeled traffic not being then practicable. Naturally most of the travel was done during the summer, as well as the transportation of merchandise. From all I can gather the best of the roads in those days were somewhat indifferent (except in the winter) and did not tend to make travelling especially comfortable. The back roads and trails may be more easily imagined than described—many of them being of the "corduroy" variety. My remarks in regard to inter-communication apply generally to all the provinces. The settlements were largely confined to the banks of the rivers and lakes, and the sea coasts. The rest of what is now the Dominion of Canada—that is the territory west of the peninsula of Upper Canada, to the Pacific, was under the control of the Hudson Bay Company, and the hunting grounds of Indians and fur traders. There were only 14 miles of rail in Canada—the line from La Prairie, opposite Montreal, to St. John's having been opened in the previous year. The provinces had not then had responsible government extended to them; they were largely governed from Downing-street, or to put it another way, the various executives were not responsible to the legislatures, and the expenses of the civil and military establishments were shared by the United Kingdom. Agitation and disaffection resulted, and led to the rebellions in 1837 and 1838, in Upper and in Lower Canada. Nova Scotia and New Brunswick also had their difficulties, but they did not lead to actual disturbances. British soldiers were found everywhere in those days, and it was not till many years afterwards, in 1871, that they were withdrawn from Canada, except so far as Halifax was concerned. Although, therefore, the commencement of her Majesty's reign in British North America was somewhat inauspicious, out of the trouble good eventually came. Representative and responsible government was inaugurated in the Canadas in 1841, in Nova Scotia and New Brunswick in 1848, in Prince Edward Island in 1851, and the foundations were thus laid of the great confederation which now unites under one Government the whole of British North America, north of the United States, except England's oldest colony of Newfoundland.

It has been rather interesting to look through the records of the different provinces in 1837. The Governors transmitted annual returns to the Colonial-office of the financial and other statistics, but the information is mostly all written, only the forms being printed. These records are therefore unique, and would be difficult to replace. In the report for Upper Canada the interesting information is given that "there are no public taxes." Probably this meant direct taxation. Although taxation is not high at the present time, the people must look back upon such a condition of things as prevailed sixty years ago in regard to taxes with feelings of envy. Much of the ordinary revenue was derived from an arrangement with Lower Canada by which Upper Canada received one-third of the duties collected at the port of Quebec. This amounted in 1837 to about £38,000. There were also duties on imports from the United States (£10,600), various receipts from the sales of land, licenses for various purposes, and tolls on the canals. The total revenue was about £417,000, and the expenditure about £412,000, but the receipts and expenditure on capital and revenue account were all lumped together. The ordinary receipts appear to have been about £100,000, a large proportion of it being expended on public works and education. Over £315,000 were spent in the year on capital account, on roads, bridges, and harbours, much of the money being raised by debentures in London, at probably more than double the rate of interest on current Canadian loans. The population was 392,000, but the returns stated that "the number of persons employed in agriculture, manufactures, and commerce cannot be ascertained." There were no parochial registers, and no other means in the province by which births, marriages, and deaths could be given. Nowadays the trouble seems to be too many statistics rather than not enough. The occupations of the people were chiefly concerned with agriculture, and the lumbering industry. Every species of agricultural product was cultivated, but there were no means of ascertaining the quantity of each. Wheat was the principal farm export, other products being chiefly grown for home consumption. No trade and navigation reports were issued. According to the returns there was no seaport in the province, and no means existed of ascertaining the positive value of its imports and exports. Steam boats and schooners were constantly plying during the navigation season, between the different ports in the province, and those in the United States, on Lakes Ontario, Erie, and Huron. The imports naturally consisted of almost every description of British products and manufactures; and the exports, of wheat, flour, lumber, wood ashes, and tobacco. The manufacturing industry had hardly commenced its existence so far as can be discovered. There were a few foundries and woollen mills, 400 grist mills, 600 saw mills, and some general factories Woollens for domestic use were manufactured throughout the province, probably by the people themselves. Whiskey distilleries, breweries and ash manufactories were numerous. The mention of half-a-dozen mines, including copper, iron and lead, of one or two marble quarries, and of silver having been found, embraced all the information given about the mineral wealth of the province. There were no regularly established fisheries in the great lakes, although it is stated that many hundreds of barrels of white fish were taken annually, and that salmon, trout, pike, black and white bass, and maskinonge and sturgeon were caught in large numbers and of great size. The prison reports are rather interesting, and tend to show that the life of the few prisoners was not altogether an unhappy one. In most of the institutions there was no hard labour, and no employment for the prisoners, who were not prohibited from receiving visits, or letters, or any articles of food or clothing from their relatives or friends. But, says one report, "They are under a certain degree of inspection by the gaoler."

The returns from Lower Canada for 1837, open with a notification that there were no laws passed during the year 1837, although the legislature met in August as usual. Some people may regard this as an ideal condition of things. It was however abnormal, and arose from the difficulties already alluded to. Another piece of information was the statement, that, as the Act providing for the support of the public schools in the province had not been renewed by the provincial legislature, it had expired on the 1st of May, 1836, and the schools having consequently ceased from want of funds, no return on the subject could be furnished. So far as can be gathered, the population of Lower Canada, the descendants of the settlers under the old French *régime*, numbered about 500,000, the revenue being about £100,000. The trade was considerable, as the figures included practically both the commerce of Upper and Lower Canada. The total imports were valued at £2,215,000, and the exports at £1,100,000. At that time almost everything had to be imported. The exports consisted largely of lumber and pot and pearl ashes.

Most of the trade was with the mother country, its proportion of the imports being £1,678,000, and of the exports £873,000. Agriculture had made but little progress, and the returns stated that "there is no possibility at present to ascertain accurately the quantity of land under each crop or the probable produce, returns only being rendered by the county of Montreal." The mention of Montreal leads me to remark that coal-gas was first introduced in 1837, a few shops in that city having then adopted the new luminant. The return relating to manufactures was a blank, and the value of the produce of the fisheries and fish oil was put down at about £61,000. Horned cattle and horses were cheap. Bread ranged from 6d. to 1s. per 4 lbs.; butter from 8d. to 11d. per lb.; beef from 3d. to 6d.; mutton from 4½d. to 8d.; rice 4d.; sugar 6d. to 9d.; salt 2d. to 3d. Brandy was sold at from 5s. to 9s. a gallon. I am told that most of the spirits were cheap and nasty, the whiskey of those days—the popular drink—closely resembling a mixture of glycerine and turpentine. The prison returns are full of points of interest. I refer to them, not as possessing any real importance, or because the matter is one that deserves prominent mention, but merely as an indication of the state of things existing in those early periods. There was no hard labour, and any money earned by the prisoners—"which," says the report, "is very trifling"—went to their own use. At the prisons of Montreal and Three Rivers there were no fixed hours of labour, and the prisoners were employed by the tradesmen in the neighbourhood. Shoemakers, it is stated, were generally found in sufficient work, as well as toy-makers. The earnings of the prisoners were paid to them by the people who employed them, or by the purchasers of the toys.

In the maritime provinces, the population of Nova Scotia, in 1837, was about 143,000, while the revenue was £75,700. The imports were £948,000, and the exports about £778,000. Great Britain sent about £365,000, the West Indies £147,000, British North America £201,000, and the United States £107,000. The exports to Great Britain were £121,000, to the West Indies £246,000, to British North America £283,000, and to the United States £55,000. It will be seen, therefore, that most of the commerce of Nova Scotia was with Great Britain, the neighbouring colonies, and the West Indies. Differential duties were imposed in favour of British as against foreign produce, and there were also imperial duties, the proceeds of which were paid over to the Imperial Government. A similar state of things existed also in some of the other provinces. An interesting feature of the trade returns is that our friends in the United States were not regarded exactly as other foreign countries. There were separate columns for Great Britain, for British Possessions, for the United States, and for foreign States. No agricultural returns were available, for the simple reason that no provision was made for the rendering of statements of the land under each crop. The report states that, "as yet there are very few manufactures in Nova Scotia, and none on an extensive scale. The manufacture of stuffs for domestic use is very common. There are several breweries and tanneries; their number is not known, but grist mills and saw mills are very common. There are three mills established in the neighbourhood of Halifax which are chiefly employed in grinding foreign grain." Coal mining was in progress to a limited extent, only three mines being mentioned—the Albion Mine, the Sydney Mine, and the Bridgeport Mine. The population of New Brunswick was about 120,000, the revenue about £70,000, and the expenditure rather less. The imports were valued at £1,058,000 and the exports at about £651,000, nearly all of which came from and went to the United Kingdom, the other British North American provinces, and the West Indies. There are no statistics to give any idea of the internal development that was taking place, or to show the number of persons employed in agriculture, manufactures, and commerce, or the births and deaths. The principal industries were agriculture and lumbering. In Prince Edward Island the population was under 32,000, while the revenue and expenditure amounted to about £13,000, to which the United Kingdom contributed about £3,000. The imports were £83,000 and the exports £37,000, the great bulk of the trade being with Nova Scotia and New Brunswick. As regards the Hudson Bay Territory very little is known. It was inhabited almos entirely by the Indians, and by the officials o the Hudson Bay Company and their families and there was little or no cultivation except in the neighbourhood of the Hudson Bay posts All the import and export trade was in the hands of the company. There are no published records, and little is known about the extent of the population. Game of al kinds was abundant, and the gathering and disposal of furs was the staple business of the community. The prairie country was the home of millions of buffaloes, which may be said to have supplied food, shelter, and clothing to the aboriginal inhabitants. The Hudson Bay officials were always on good terms with the Indians. They could go anywhere with perfect safety, and the foundation of the good relations that existed was confidence. An order on the Hudson Bay Company from any of its officials was always honoured, promises were always kept, and the friendly relations which were thus encouraged made the subsequent transfer of the territory and its inhabitants to the Dominion of Canada a comparatively easy matter.

These short and very general accounts of the different provinces of British North America are necessarily imperfect, for the reasons I have explained. Records were few and far between, and the administration of the country was still largely carried on by the Imperial Government. The more general remarks of course apply largely to all of the provinces. The population, about 1,250,000, consisted chiefly of the descendants of the French in Lower Canada, and, in the other provinces, of the descendants of the people who left the United States during the War of Independence, and afterwards, because of their love and affection for the British flag, and of their determination to remain British subjects. Immigrants were also commencing to arrive in large numbers from the United Kingdom. The pioneer settlers naturally had a hard struggle, but their difficulties were surmounted, and their descendants and those of the French Canadians form the backbone of the Dominion today. While, as has already been pointed out, the foundations of Canada may be said to have arisen upon British loyalty, it should be added that although the French Canadians are naturally proud of their ancestry, and the country of their origin, there are, at the present time, no more loyal subjects of her Majesty than those we familiarly describe as French-Canadians, or as Canadians who speak French as well as English. In 1837, the only incorporated city in Canada was Toronto, which at that time had a population of from 13,000 to 14,000. Many places, which could only be described then as hamlets or villages, are now well-known and substantial towns and cities. To quote from Martin's "History of the Colonies," published in 1845:—"Little more than 30 years ago, the site whereon York (that is Toronto) now stands, and the whole of the country to the north and west of it was a perfect wilderness. The land is now fast clearing, and thickly settled by an industrious European and European-descended population, blessed with health and competence, and on all sides indicating the rapid progress of civilisation." In Lower Canada, Quebec, at that time, was a more important town, in many ways, than Montreal. It was at the head of navigation, as the shallows in Lake St. Peter, on the St. Lawrence, had not then been dredged, and only vessels drawing about 9 feet of water could pass up the river. Consequently, it was the *entrepôt* of a greater share of the St. Lawrence than it is now. A few ocean vessels of light draft went up to Montreal, but much of the merchandise for that city was transshipped at Quebec into other vessels. Quebec was also a somewhat important military centre. Nowadays, things have changed. Quebec has lost none of its picturesque beauty, and is still one of the show places of Canada, but its population is only 70,000, as against that in Montreal, with its suburbs, of nearly 300,000. The bulk of the St. Lawrence trade is centred at Montreal, although facilities have been provided at Quebec for the reception and distribution of an extensive commerce. The settlement of Canada has always proceeded on rather different lines from those observed in some other colonies. The two largest cities in Canada, to-day, contain little more than from 250,000 to 300,000 people each, but there are numerous hamlets, villages, towns, and cities all over the country, as in England. They are not only markets for the farmers, and pleasant residential places, but they are the nuclei of the manufacturing industry, which is now becoming a prominent one in the Dominion. The lumber-men were the pioneers of civilisation. They cut down the trees along the banks of the lakes and rivers, and floated the logs to sawmills or the sea-ports, as the timber was required for home consumption or for export. They were followed by the hardy pioneer settlers, who cultivated the land between the stumps, and cleared their farms out of the bush. At places where water-power was found, grist mills and sawmills were established, and attracted settlement. Indeed, out of these little centres arose many of the modern towns and cities. Emigrants at the present time can form no idea of the difficulties the early pioneers had to encounter. There were no luxurious ocean steamers in those days, and the voyage across the Atlantic in the ordinary emigrant ship, on which the passengers had to provide their own food, could not have been a very pleasant experience. Then, again, the clearing of a farm out of the forest was work hard enough to make a young man an old man. No one travelling through Ontario and the other provinces to-day, with their splendid farms and orchards would imagine that the state of things to which I have referred could possibly have existed only sixty years ago. This was before the days of prairie land, which settlers can now obtain in Canada, free of charge, unencumbered with trees, and ready for the plough. Railways did not make much progress until about 1850. Steam communication across the Atlantic commenced in 1838, but there was no regular service till the Cunard line was started in 1841. Those were the days of the wooden ships, for the construction of which Canada has always been, and is still, famous. There were a few steamboats on some of the rivers and lakes as already mentioned, but the development of steam was yet in its infancy. Canada, however, enjoyed the proud distinction of having built the first steamer that crossed the Atlantic, the *Royal William*, launched at Quebec in 1831. Even sixty years ago the fertility of the soil of Canada was recognised. Martin, the historian, stated that "the quantity of good soil compared to the extent of the country is equal to any part of the globe, and there yet remains locality for many millions of the human race,"—a statement which may be taken as applying to all British North America, and certainly holds good at the present day to an even greater extent than was imagined sixty years ago. Martin adds that "so great is the fertility of the soil of Canada that 50 bushels of wheat to the acre were frequently produced on a farm where the stumps of trees, which probably occupy one-eighth of the surface, have not been eradicated. Some instances of 60 bushels per acre are stated to have occurred, and near York in Upper Canada, 100 bushels of wheat were produced from a single acre, while in some districts, wheat has been raised successively on the same ground for twenty years without manure." I am not prepared to altogether vouch for the accuracy of these figures. Farming then was not so scientific as now, and statistics were not recorded with that care to which we are accustomed; but even if some of the figures are discounted to the extent of one-half, they would nowadays be regarded as satisfactory.

Mention has already been made of the travelling facilities in Canada at that time; but I have been told that the journeys by stages and lumber wagons were not so very tedious as might be supposed. Travellers made themselves as happy and as comfortable as possible, in the knowledge that in any case they would not get over the ground more quickly. Even in 1853 the journey by stage from Quebec to Windsor took ten and-a-half days, from Quebec to Toronto seven days, and from Quebec to Ottawa three days. The hotels are said to have been very fair along the front road, and the food, if homely, varied and well-cooked. Of the inns and hotels in the back settlements, my informants do not speak so highly. The accommodation was indifferent, and as to food it was a case of tea, ham and eggs for breakfast; eggs, ham and tea for dinner; and ham, eggs and tea for supper. If report be true, one had at times to be told that the meat was ham before being able to appreciate the fact. A story is told in these times of a man who asked to which inn in a certain district he should go; the reply was that it did not matter very much, because if he went to any one, he would probably wish the following morning that he had gone to another. The postal system of Canada at this time was under the control of the imperial authorities, and so remaining until 1851—yielding a not inconsiderable annual revenue. Everything was managed from London. It is curious to read in Martin's History that the sums received for the transmission of newspapers and pamphlets by post have, "ever since the establishment of the Post-office in British North America, been the emolument of the Deputy-Postmaster-General, out of which he allows to his subdeputies a commission for collecting of from 10 to 20 per cent., which allowance is in addition to their earnings as Postmasters." Mr. Martin added, "nearly the whole of the newspaper postage in Upper Canada, £4,000, went to Quebec, and formed the perquisite of the Deputy-Postmaster there." At this time the rates of letter postage in Upper Canada were 4d. from one to fifty miles, gradually increasing until it become 1s. 6d. for 500 miles. The charge, however, for newspapers was ½d. each. In 1838 there were only 380 post-offices in Canada, and 5,486 miles of post route. When the regular steamship communication commenced across the Atlantic in 1841, the uniform charge of letters was to the United Kingdom 1s. 2d. per half an ounce, which is believed to be the first recorded uniform rate of postage, irrespective of distance. In 1851 the rate of postage in Canada was reduced to 5 cents per half an ounce, and 12½ cents to the United Kingdom. The development of postal communication in Canada will be recognised when it is stated that in that year there were 601 post-offices, the number of letters carried being 2,132,000; that in 1861 the post-offices had increased to 1,775, and the letters to 9,400,000—to which the leading cities, Quebec, Montreal, Kingston, Ottawa, Toronto, Hamilton, and London supplied over 4,000,000, and that in 1895 there were 8,882 post-offices, while the number of letters carried had increased to nearly 140,000,000.

While we can never tell what is going to happen in the future, it is easy enough to look back upon the past, and to recognise the various events which have tended to bring about the great progress witnessed in Canada in the past 60 years. As already mentioned, the provinces of British North America, in 1837, were scattered and separate communities, with very little intercommunication. Two of them were in the throes of internecine disturbance, and the Constitution of Lower Canada was suspended in 1838. This led to an inquiry on the part of the home Government into the condition of affairs, and to Lord Durham's famous report. The re-union of Upper and Lower Canada followed in 1841, and undoubtedly laid the foundation of the greater union established some 26 years later. The year 1840 witnessed the incorporation as cities of Quebec and Montreal, and the issue of the first daily newspaper in Canada, *The Montreal Advertiser*. Two years after, the settlement of the eastern boundary line between Canada and the United States was settled by the Ashburton Treaty. Canadians do not forget that, if the interests of the country had been better safeguarded, a not inconsiderable part of New England might now have been under the British flag. In the same year the last tariff framed by the Imperial Government for the British possessions was brought into operation, and in 1846 the British colonies of America were authorised to reduce and repeal, by their own legislation, duties imposed by Imperial Acts on foreign goods imported from foreign countries. From the latter year may be said to date the fiscal independence of Canada. Up to that period articles of colonial production had enjoyed preferential treatment in Great Britain. Even in the Act of 1846 discrimination was made in favour of wheat, and a number of other articles coming from the Colonies, and it was not until 1860 that all the preferential duties were abolished. In 1843 Vancouver Island began to assert itself, Victoria, the present capital of British Columbia, being founded in that year, under the auspices of the Hudson Bay Company. In 1846 the boundary between Canada and the United States west of the Rocky Mountains was determined. The extreme western frontier settled upon was a continuation of the 49th parallel of latitude, and not the natural one formed by the Columbia River. In 1852, the Grand Trunk Railway was commenced. The first ocean steamer arrived at Quebec in 1853, and 1854 saw the opening of the main line of the Great Western Railway of Canada, now a part of the Grand Trunk system, to which Canada owes so much. A reciprocity treaty was arranged in the same year with the United States, and lasted until 1866 with mutual advantage to both countries. It was terminated by the United States, but on many occasions Canada has since expressed a desire for improved relations with her friends and neighbours. The Allan Steamship Line commenced at this time a regular fortnightly service between Great Britian and Canada, followed by a weekly service three years later. This improved communication laid the foundations of that immense trade which, during the season of navigation, is conveyed by the St. Lawrence River, and viâ Halifax, St. John, and American ports during the winter. The decimal system of coinage was adopted in Canada in 1858. In that year Ottawa was selected by her Majesty as the capital of Canada, and subsequently became the capital of the Dominion. It was also remarkable as witnessing the laying of the first Atlantic cable between England and Nova Scotia. The first gold discoveries were made in 1858, both in British Columbia and in Nova Scotia. Large quantities of gold were obtained from the Cariboo district, in the former province, notwithstanding its inaccessibility, and the difficulties of transport. The rush of people brought about the establishment of British Columbia. New Westminster was founded in 1859, and was the capital of the mainland of British Columbia until it and Vancouver Island were united in 1866. About this time attention was beginning to be directed to the Hudson Bay territory. Rumours were current as to its fertility and adaptability for settlement. What is now Winnipeg, I city of 35,000 people, was then known as Fort Garry, the chief post of the Hudson Bay Company. The year 1860 was a red-letter year in Canadian history, owing to the visit of the Prince of Wales. During his stay in the country, His Royal Highness opened the Victoria-bridge, one of the longest tubular bridges of the world, over the River St. Lawrence at Montreal, and laid the foundation-stone of the Parliament buildings at Ottawa—erected at a cost, including the departmental offices, of nearly £1,000,000. They are a source of pride to Canadians, and of much interest to visitors. The sixties were chiefly remarkable for the movement in favour of confederation. Difficulties were being experienced in Upper and Lower Canada, owing to the Constitution of the Parliament, and to the more rapid increase in the population of the former, and legislation was at a deadlock. A proposal was also under consideration for the union of the three maritime provinces of Nova Scotia, New Brunswick, and Prince Edward Island, and after much consideration and negotiation by the statesmen from the different provinces —who are now known as "The Fathers of Confederation," most of them no longer with us—the Dominion of Canada was brought into being. In the first place it consisted of Nova Scotia, New Brunswick, Upper Canada, and Lower Canada, the two last-named thenceforth to be known as Ontario and Quebec. Arrangements were made immediately afterwards for the acquisition of the Hudson Bay territory. Out of that immense region the province of Manitoba was formed, and the North-West territories, the latter being afterwards subdivided, but still remaining under one Government, into the districts of Assiniboia, Saskatchewan, Alberta, and Athabasca. Later on other districts still further to the north were created—Ungava, Franklin, Mackenzie, and Yukon, but they are still mere names, and as yet unorganised. British Columbia joined the Confederation in 1871, followed in 1873 by Prince Edward Island, and in that year the whole territory from the Atlantic to the Pacific, exclusive of Newfoundland, became consolidated under one Government.

The transfer of the Hudson Bay territory was not completed without much local difficulty, culminating in what is known as the first Riel Rebellion, which however came to an end before the arrival of the military forces under Colonel, now Field-Marshal Lord, Wolseley. No better idea can be given of the difficulties of reaching the western country, at that time, than a mention of the experiences of the expedition. It took Colonel Wolseley three months to take his force from the end of Lake Superior to Fort Garry, while to-day the journey can be made by train in less than twenty hours. Confederation naturally paved the way for the development of Canada, but much remained to be done. The union could not be made really effective until the provinces were placed in communication with one another, their varied resources exploited, and made accessible, and the means of transport established for the movement, internally and for export, of the produce of the mines, the forest, the fisheries, the fertile soil, and the potential manufacturing industries. The British North-America Act provided for the construction of the Inter-colonial railway, to connect Halifax and St. John with Quebec, and with the Ontario system of railways. The terms of admission of British Columbia included the building of a railway to connect Ontario with the Pacific coast. In 1876 the Inter-colonial railway was opened. The Pacific Railway surveys began in 1871, and the road was to have been completed in 1881, but the task was too stupendous to permit of its being carried through in that time. Surveys were made and pieces of railway constructed here and there, but it was not until 1881 that the work can be said to have commenced on an active basis. A contract was then made between the Government and a syndicate, including Sir George Stephen (now Lord Mount Stephen), Si Donald Smith, and others—out of which grew the Canadian Pacific Railway Company. They undertook to complete the line in ten years but it was conducted with such activity and splendid energy that the last spike of the railway was driven at Craigellachie, in the Rock Mountains, on November 7th, 1885, by Si Donald Smith, the present High Commissioner for Canada, to whom the successfu carrying out of this immense and importan work is largely attributed. To use the word of an American statesman, the railwa transformed Canada into a united nation Valuable as it is for trade purposes, givin Canada an outlet both on the Atlanti and on the Pacific, and providing a ne imperial highway from England to the Eas even as far as India, it has importar political and strategical considerations whic are too well known to need repetition. Th line was constructed without the assistance a penny of imperial money. It was largel subsidised by the Dominion in land, in partly constructed railway, and in money; and the interest upon the outlay represents a charge on the revenue of at least £1,000,000 sterling a year. Although the proposal created much opposition at the time, as being of too onerous a nature for the small population, hardly a Canadian will be found to-day who does not admit that the Canadian Pacific Railway has made the Dominion, and has laid the foundations of a grand future for the country, the importance of which even now cannot be foreseen. The western terminus of the railway was in effect extended by the establishment of a fast steamship service to Yokohama and Hong-Kong, in 1887, followed by the Huddart line of steamers from British Columbia to Australasia, in 1893, the former subsidised by Canada and the United Kingdom, and the latter by Canada and some of the Australasian colonies. Many branch lines have been constructed in Manitoba and the North-West, and in British Columbia, and in the last-named province, particularly, further extensions are now under consideration and in progress, with the object of opening up its immense mineral resources.

The progress of the Western country was unfortunately not permitted to continue without further difficulties, and there was another local disturbance in the North-West Territories in 1885. It was, however, suppressed by Canadian forces, 4,000 of the Canadian Militia responding to the call to arms in a few days. This reference to the militia leads to the remark that it is purely a voluntary force, maintained n a high state of efficiency by the spirit of oyalty which exists everywhere in Canada, from the Atlantic to the Pacific. These volun-eers have shown their valour in local disturbances, and when attack has been threatened from without; and the assistance rendered to he Nile Expedition, some years ago, by the Canadian Voyageurs, who were under the command of officers of the Canadian Militia will be remembered. In fact, the Canadian Militia has a record of which the military powers in other countries would be proud. The skill shown by its riflemen in times of peace at Bisley and Wimbledon is well known; t is only two years ago since Canada njoyed the proud distinction of carrying off the coveted "Queen's Prize" at Bisley, and last year the Canadian artillery team won the Queen's Purse at Shoeburyness. The treaty of Washington in 1871, has had an important bearing on the relation between Canada and United States. The clauses regulating the mutual enjoyment, to a certain extent, of the fisheries of the two countries were abrogated by the latter country in 1885. Another attempt was made to dispose of this troublesome question in 1888, but the treaty was not ratified by the Senate. The provisions of the Convention, in the arrangement of which the present Secretary of State for the Colonies, in conjunction with Lord Sackville and Sir Charles Tupper, took an important part, have, however, practically been in operation as far as Canada is concerned, with the happy result of removing much of the former friction. The last decade saw the Indian and Colonial Exhibition in London. Canada has taken part in some of the leading exhibitions in different parts of the world, and has always achieved a high position, in competition with other countries. At Philadelphia in 1876, Canadians carried away 300 prizes; in 1878 at Paris 225 awards were secured, while at Chicago, Canadians obtained great distinction and 2,126 awards. It was, however, in London in 1886, that Canadians first had the chance of displaying to their fellow British subjects in the United Kingdom, the rapid strides they were making in agriculture, in the manufacturing industries, and in developing the wealth of the mines, the forests, and the fisheries of Canada. Much attention was attracted by the variety and excellence of the display, and it did a great deal to dispel many of the misapprehensions that had prevailed about the climate and resources of Canada. The Imperial Institute of the United Kingdom, the Colonies and India was founded in the following year, as a memorial of the Jubilee of Her Majesty's reign.

The year of 1887 will always be remembered in the history of the Colonies, as witnessing the summoning of the first Colonial Conference, which brought representatives of all the self-governing colonies to London for consultation with the Imperial Government on matters affecting the general well-being of the Empire. It gave expression to the growing feeling in the United Kingdom, and in other parts of her Majesty's dominions, in favour of a closer union for material and political purposes between the galaxy of nations which make up the British Empire. It was followed by the, perhaps, even more important gathering in 1894. In that year the self-governing colonies were invited by Canada to send representatives to Ottawa. Nearly all the colonies responded, and the Imperial Government was represented by the Earl of Jersey, whose report will take rank as one of the most important State papers of modern times. No one can deny the importance of the discussions that took place. The Conference passed resolutions in favour of closer commercial relations between the Colonies and the mother country, and of the provision of better steamship and cable communication, all the proposals being calculated to bring the different parts of the Empire into closer union. The seed sown by the commercial resolutions is undoubtedly growing. Not only has the seed itself great germinating power, but a strong fertiliser is being applied in the shape of the growing competition which British trade is everywhere meeting. The fast Atlantic service to connect with the Canadian Pacific Railway, and the existing steamship services on the Pacific, has taken a distinct step in advance by the promise of the Imperial Government to assist in its establishment. The Pacific cable has also been brought within the region of practical politics as the result of the deliberations of the committee, recently appointed by Mr. Chamberlain, representing the Imperial, the Canadian, and the Australasian Governments. Prophecy is always risky, but it seems a pretty safe thing to predict that the next decade will see the Colonies and the mother country brought closer together, both politically and commercially, than ever before.

So much of my time has been taken up with a sketch of Canada in 1837, and of some of the leading events since that time, that only a comparatively few moments are now at my disposal in which to give an idea of the Dominion as it is to-day. As already mentioned the different provinces are united not only for purposes of government, but they are bound together by those great means of civilisation and progress—Railways and Telegraphs. The various provinces have local Parliaments, with full power to manage their own affairs. The Federal Parliament, in which they are all represented, deals with matters affecting the general community. There are no local jealousies to speak of, and all the provinces are co-operating in order to develop and render accessible the great western country which is bound to become not the least important part of the Dominion. There are 16,000 miles of railway in operation; daily trains run between the Atlantic and the Pacific, and the older parts of Canada are as well served by railways, having regard to the population, as any other part of the world. The same remark applies to the western portions of the Dominion, which only commenced their actual career with the opening of the transcontinental railway little more than ten years ago. There is also a through water-way from the end of Lake Superior to the Atlantic, entirely through British territory, a distance of 2,600 miles. On that work many millions of dollars have already been spent, and it is in contemplation to so deepen the canals that, in the near future, it will be possible for steamers to sail direct from the Lakes to Europe, carrying at cheap rates the abundant produce of the fertile western prairies. The largest sea-going steamers trade regularly to and from Canadian ports. Owing to the energy of the inhabitants of Montreal, assisted as they have been by the Government, vessels drawing 27½ feet of water can moor alongside the streets of that city—700 miles from the Atlantic Ocean. The telegraph is found in almost every settlement in the Dominion. There are 28,815 miles of line, and 68,244 miles of wire, in operation, exclusive of 2,720 miles of Government line, and there are 2,556 offices open to the public. Electricity in the shape of telegraphs and telephones, lighting and motive power, is utilised in Canada to an extent unknown in the United Kingdom. Most of the Atlantic cables land on Canadian soil. The lighthouses are, generally speaking, connected by telegraph, and the present year will probably see a telegraph station established in the Straits of Bellisle. The proposed Pacific cable will be a most important work, not only to Great Britain, but to Australasia and Canada. Much the same may be said of the long talked of extension of the Halifax and Bermuda cable to the West Indies. The postal system is cheap and effective, the rate being 3 cents per pound from one part of Canada to the other, even from Halifax to Vancouver, a distance of over 3,000 miles. There is a lower rate for local postage, and up to the present time newspapers sent direct from the office of publication to subscribers have been carried by the post-office free of charge. The population of Canada now numbers over five millions. It consists of British and French Canadians of many generations, a large sprinkling of Englishmen, Irishmen, Scotchmen, and Welshmen, and of the inhabitants of the various countries of Europe. Foreigners soon recognise the advantage of the system of government in Canada; they invariably become naturalised, and their children grow up as loyal British subjects as those whose forefathers have been reared under the beneficent influences of the British flag. The last census shows that there were 46 cities and towns of 5,000 inhabitants and upwards, of which, however, only nine exceeded 20,000. There were 46 towns with from 3,000 to 5,000 people, and 91 villages containing from 1,500 to 3,000 people. Smaller settlements are found all over the country. The urban population in 1891 was nearly 1,400,000, or 28·77 of the whole, and 45 per cent. of the people are engaged in agriculture. Social distinctions do not exist in Canada to the same extent as in many other countries. A feeling of healthy independence pervades all classes. Nearly every farmer is the owner of his acres; he is his own master, and is free to do as he wills. Taxation is comparatively light, and many of the social difficulties still under discussion in older countries were grappled with in Canada years ago. Religious liberty prevails, and there is an excellent system of free and unsectarian education. Colleges and universities of more than local repute are found in every province, and afford facility for the highest training at moderate cost. There is no need for a Poor-law system, but the orphans and the helpless, the aged, and sick, are not neglected, being cared for under the municipal system, and in the hospitals. A free and liberal franchise exists, and local option in regard to liquor traffic is in operation. The duration of Parliaments does not exceed five years, and members are paid for their services. An excellent system of local or municipal government is at work in the provinces. Newspapers are published in every village; and Canada is gradually developing a literature of its own. Only a fringe, however, of the available territory is yet inhabited. There is room for ten millions of inhabitants, and the great wants of the country, at the present time, are more people and more capital. It is not too much to say that those who are seeking "fresh fields and pastures new," no matter to what class they belong, will find in Canada advantages not to be excelled in any part of the world. Too much money and muscle have left the United Kingdom for foreign countries in the past, but evidences are not wanting to indicate that the British colonies are attracting more attention. The rapid increase in the population of the Colonies, to bring about which immigration is needed, must tend to the development of their resources, and to the increase of their productive and consuming capacities. The colonial markets afford greater possibilities for the increase of British trade than are found in any other parts of the world—a fact which should be borne in mind when the question of emigration is under consideration. In Canada the Indians have always been treated fairly and honestly, and successive Governments have done their best to enable them to obtain a livelihood, and to take their place side by side with the white man. Their progress has been slow but it is encouraging, and this is especially the case with the rising generation. In the older parts of the Dominion the Indians are self-sustaining and the franchise has been extended to them. A few words may be said about the administration of the law in Canada. The provinces control the civil law and the Dominion the criminal law; and it has always been properly administered, Lynching is unknown, and would never be tolerated. What might be unruly communities in the newly opened up mining camps are no exception to the general rule, and law and order are as much observed there as elsewhere.

The trade of the Dominion has advanced by leaps and bounds. Its commerce cannot fairly be compared with former times, as the present intercolonial trade was then inclnded in the imports and exports. No actual statistics are available to show the interchange of commodities between the different provinces, but an idea may be formed of its extent by the 21,500,000 tons of freight carried over the railways in 1895. In 1875 the quantity was only 5,671,000 tons. The tonnage of vessels in the coasting trade and on the lakes increased from 14,300,000 tons in 1876 to 33,600,000 tons in 1865. The imports of Canada for the year ended June last were valued at £23,600,000, as compared with £14,700,000 in 1868, and probably about £4,000,000, at the outside, in 1837. The exports were £24,200.000 as against £13,500,000 in 1868, and about £2,400,000 in 1837. Great Britain and the United States divide most of the trade. The imports from Great Britain consist chiefly of manufactured products, while the imports from the United States are either raw materials, which Great Britain does not export, or manufactured articles in which, from the force of circumstances, she is not able to compete with the great republic. The export trade in food supplies is largely with the United Kingdom, although the United States is also a customer; but to the latter most of the exports consist of the produce of the mine, the forest, and the fisheries, much of the two first-named being properly described as raw materials. Canada also has a large and increasing trade with various countries in Europe, with South America, with China, Japan, and Australasia; and the development of her resources and the improved means of communication seem to indicate the possibility in the future of a great expansion in her trade. The revenue of the Dominion is about £7,000,000 per annum, exclusive of the revenue of the provinces. And one half, equal to 14s. 6d. per head, is raised by customs duties. In the matter of credit the country occupies a high position, its 3 per cent. securities being now quoted above par. Closely connected with trade and credit is the banking system of Canada, which is regarded as one of the best in the world. Of the 38 banks making returns to the Government, ten have head-quarters in Ontario, fourteen in Quebec, eight in Nova Scotia, three in New Brunswick, two in Prince Edward Island, and one in British Columbia. These banks have a large number of branches, and there is no lack of legitimate financial facilities in any part of Canada. There are also Post-office savings' banks, and other Government and special savings banks, mostly used by the working classes. The deposits in these banks have advanced from $5,000,000 (£1,000,000) in 1868, to nearly $58,000,000 (£11,600,000) in 1895, which is eloquent testimony of the continual improvement in the social condition of the people. The amount of such deposits per head of the population in 1871 was $2·96 (12s. 4d.), and $11·32 (47s. 2d.) in 1895. Agriculture is probably the most important industry of the country. According to the census of 1891, the area of improved lands in Canada was 28,527,242 acres, of which 19,904,826 acres were under crop. There were 464,462 acres in gardens and orchards, and 15,284,788 acres in pasture. The increase in lands under crop in 1891, compared with 1881 was 4,792,542 acres. In Manitoba and the organised districts of Saskatchewan, Assiniboia, and Alberta, there are nearly 239,000,000 acres, of which only 7,832,000 acres have been brought into use by farmers and ranchers. There is room for much expansion in the older provinces, and the possibilities in the great west are practically illimitable. The different provinces grow all the staple cereals and roots, vegetables and fruits that are produced in England and many others that are not cultivated here in the open air. Over 6,000 tons of grapes are annually raised, and the wine-growing industry is rapidly developing, while the cattle raising and dairying industries are of exceptional importance. Not only is enough food of various kinds produced to feed its inhabitants, but large quantities are annually exported, chiefly to the United Kingdom, where Canadian produce of all kinds are becoming well known. Large numbers of people are engaged in the lumber trade, and in the fisheries, while the towns, particularly in the older parts of the Dominion, are generally the seat of the manufacturing industries, which have developed to so great an extent in Canada since Confederation and the extension of the railways. The manufacturing industry in Canada is comparatively in its infancy. The census of 1881 showed that the capital invested was $165,000,000 (£33,000,000), and the men employed 254,894; in 1891 these figures had increased to $355,000,000 (£71,000,000) and 370,256 respectively. Most of the manufactures are used to supply local consumption, but the export is not inconsiderable, being in 1895 of the value of $26,144,376 (£5,229,000). The number of manufacturing establishments increased from 49,731 in 1881 to 75,968 in 1891, and they include everything from the button to the steam-engine. The country is especially favourably adapted for the development of manufactures, as it possesses abundant water-power (including Niagara Falls), timber in large quantities and most of the economic minerals, while the facilities for the importation of raw material, and for the distribution of the manufactured article both internally and externally, are excellent. The fisheries are not only important in themselves, but they provide a reserve of hardy sailors, which might be more utilised than they are in connection with the navy. Probably, there are about 70,000 men and boys engaged in that industry, apart from the large number employed on the wooden ships of Canada, which are found in every sea. As regards minerals, Canada promises, without exaggeration, to show, in the near future, results equal if not superior to any other part of the world. There is abundance of coal, both on the Atlantic and on the Pacific coasts, a factor of great importance to the manufacturing industry, and to the British fleets operating in those waters. Coal is also found on the prairies and in the mountains of British Columbia; iron is abundant, and copper and lead, while silver is found at intervals all the way from the Atlantic to the Pacific. Mention has already been made of the discovery of gold in Nova Scotia and British Columbia. Mining development is now rapidly proceeding, both in the former province, in Quebec, and in that part of Ontario between Lake Superior and Winnipeg. It is, however, upon British Columbia that the observation of the larger number of people is at present concentrated, and the general impression of experts who have visited the country seems to be that it will rival both South Africa and Western Australia in its gold-producing qualities.

The great progress of Canada in her Majesty's reign may be said to date from the time when responsible government was given to the different provinces. There are those even now, who seem to regret that the hold of the United Kingdom upon the outlying portions of the empire was thus weakened; but it must not be forgotten, that the Colonies were sources of expense to the mother country in the early days. In addition to the general contributions given to the Provinces of British North America the military expenditure in 1837 was probably more than half a million sterling. Now all this is changed, and the great colonies are entirely self-supporting. Self-government led to a feeling of healthy independence, and a readiness to shoulder responsibilities which might not otherwise have rapidly developed. Canadians have spent large sums of money in developing railways and waterways, and steam-ship lines, which would hardly have been done under Imperial or even under private auspices. The past 60 years have done wonders for Canada; but, great as its progress has been, those who study the question feel that its future is full of even greater promise. Canada owes much to the various Governors-General who have represented her Majesty, and to her illustrious statesmen, whose names adorn the pages of history, and will always be identified with the country they loved so well, and served so truly. Her Majesty's long and glorious reign will be celebrated with great enthusiasm in the Dominion. The gracious invitation which has been conveyed through the Governor-General that Canada should be specially represented in the United Kingdom on the occasion, not only by the presence of her Premier—the Hon. Wilfrid Laurier—but by a detachment of the local forces, will serve to strengthen, if it were possible, the loyalty and devotion of her Majesty's subjects in that part of the Empire. It is the first time that the Colonies will have taken part officially in any great public occasion. The gathering will also afford an excellent opportunity of discussion among the statesmen of the Empire of many public questions affecting the general well-being of the British community. Viewed from an imperial standpoint, Canada and the Colonies are, and have always been, bound to the mother country by a slender thread. If the results with which we are familiar have sprung from a union so unique and novel, what might not be expected from a union of material interests and of hearts—unity for commerce, unity for defence, unity which would give the different parts of the Empire a voice in all matters connected with its well-being; unity in which they would feel and share more than they do now the responsibilities of the Empire to which they are all proud to belong? Is not this the grand ideal to keep always before us—the goal we should all strive to reach? Only one word more. The Colonies are loyal to the throne and to British institutions, and not the least remarkable feature of the Victorian era will be their rise and development; but they do not find a place among the titles of the Sovereign. May we not look forward to this omission being rectified in this year—the sixtieth year of her Majesty's reign; and if legislative sanction is necessary, such an Act could not be otherwise than among the most popular measures ever passed by Parliament, and would cause the greatest possible enthusiasm among her Majesty's subjects in every part of the Empire.

DISCUSSION.

Sir **Donald Smith**, K.C.M.G., said he did not come that evening to speak, but to listen, because he knew from his intimate acquaintance with his friend Mr. Colmer, that anything he said would be full of interest and instruction, that it would be to the point in every respect and thoroughly reliable. He had listened with very great satisfaction to what had been said. He also considered that the Marquis of Lorne, as chairman of that meeting, was the right person in the right place. In Canada, they had a most agreeable experience of the Chairman's administration, and of the admirable manner in which the duties of the Governor-General were carried out, supported and assisted as he was by the daughter of Her Majesty, for whom they all had the greatest regard. He felt that if anything was omitted by Mr. Colmer it would be made up by the Marquis of Lorne, who had done so much in his time for Canada. Some of the figures referred to that evening might startle English farmers, such, for instance, as that land was capable of producing 100 bushels per acre. He recollected, some years ago, the Rev. Dr. Lachlen Taylor addressing a meeting in the north of England. He said that when in Manitoba having heard of the large size of potatoes, he asked the good woman of the house whether she would show him one. She went into the cellar, and came up with an American pail of 2½ or 3 gallons full of potatoes. He asked his audience, "How many potatoes do you think there are in the pail?" and himself answered, "Just ten." Many looked upon that as a traveller's tale, and when the meeting broke up, Dr. Taylor said to the Rector, "What do you think of the lecture?" "Very good," was the reply, "but I think I would have thrown, at least, half-a-dozen more potatoes into that pail." But he (Sir Donald) could answer for it that the size had not been exaggerated. He had seen, many times, potatoes, ten of which would have filled the pail. Some of them weighed 3½ lbs. each, and were good to the very core. The same remark applied to wheat. In the North-West the very finest was grown, and it had such a reputation upon the market, that it fetched from 1s. to 2s. more per quarter than that grown in other places. During his long residence in Canada, which began one year after Her Majesty ascended the throne, he had been a witness to much of what had been spoken of that evening. Considering the progress that had been made by Canada during the last 59 years, it might well be expected that in another 25 years it would still be the foremost of the outlying parts of the Empire. Canadians were devoted to their Queen and loyal to the Crown. Their greatest desire was to help in drawing more closely the bonds uniting the Empire. Canadians were as much Englishmen and British as any in the home country. Whether the mother tongue was English or French they were all as loyal and as true to the Queen and to the Empire as it was possible for any body of people to be.

Sir CHARLES KENNEDY, K.C.M.G., said it was his very great pleasure to propose a vote of thanks to Mr. Colmer. The paper to which they had the evening listened was both interesting and instructive; it was valuable as a permanent record of the social and political progress of the Dominion, and it contained materials which would always be useful to the historian and to the student of social problems. Canada had been particularly fortunate in the ability and the high character of her statesmen. These eminent men had done very much to promote the best interests of the whole Empire. The High Commissioners who had respectively represented the Dominion in London had on their part done much to maintain close relations between the mother country and the Dominion of Canada. It had been his privilege to take part in the labours in international questions of Sir Alexander Galt, and Sir Charles Tupper. In the wonderful and good work which the High Commissioners had done, they had been much aided by Mr. Colmer who acted quietly, and in a manner which became a civil servant who held a responsible and delicate position. He would not add to the well-chosen words in which the noble Lord, who had so kindly come among them that evening, had spoken of Mr. Colmer. It was sufficient to ask the audience to show their appreciation of the value of Mr. Colmer's paper, and of the trouble and labour which he had devoted in its preparation, by according to him a very hearty expression of thanks.

Professor ROBERTS-AUSTEN said it was a matter of great importance to Englishmen that they should find some outlet for the rising generation, and as Professor of the School of Mines, he was particularly pleased to learn that many of those who had passed through that school would take part in developing the Dominion of Canada.

Mr. BECKETT HILL said he had had the pleasure of knowing Mr. Colmer in connection with his post of High Commissioner, and he was sure that everyone would agree that his connection had been most useful to the great Dominion. Although Mr. Colmer had given a very interesting account of the 60 years' reign of Her Majesty, he did not know whether that gentleman had been able personally to take much part in it. Still the paper was a well-written one, and, what was more important, a well-read one. Many excellent papers were spoilt by the reader, but it had not been so that evening. It was now thirty years ago since he entered the shipping firm whose steamers had done something towards developing the Dominion of Canada. His first recollection after entering the firm was the confederation of Canadian enterprises, of which they had heard that night, and when the word "Dominion" was chosen he thought it was a most happy selection. He suggested that some arrangement be made for developing the agricultural resources of Canada. Some slight preferential duty would not be felt in England, but it would have the effect of soon populating Canada. Another thing which was necessary was that there should be a fast steam service to Canada, in order to put the country on a level with New York. Although banks and other buildings had increased in Canada, he was glad to say that freights had not increased.

The CHAIRMAN, in putting the vote to the meeting, said it was no small thing to have gone over the whole subject in so short a time as one hour, especially when they remembered that Mr. Colmer had had to wade through the old reports of Governors. If Canadian archives were to be exploited and read they had as a rule to come to the records at Paris and London, but this defect the Canadian Government were now trying to correct. He would strongly urge upon ladies to diligently search among old letters which they had received from Canada many years ago, as he noticed the other day that an ancient Canadian 1s. stamp with a black Queen's head upon it fetched no less than £60 in the stamp market. It was a remarkable thing that whereas the Imperial authorities always insisted upon having a revenue from the Post-office, in Canada they were far in advance of such an antiquated notion. One remarkable circumstance in reference to the enormous internal traffic in the waterways of Canada always brought home to his mind the extraordinary rise of the country since the early days, and there was the fact that the tonnage passing through the canal from Lake Superior to Europe was greater than that which passed annually through the Suez Canal.

The resolution having been carried,

Mr. Colmer, in reply, said he felt greatly indebted to the Chairman for having presided, and for the kind references which had been made to his paper. He was fully conscious of its shortcomings, but the subject was a very large one, and he had had but a very short time in which to deal with it. He had touched upon many things in a far lighter manner than they deserved, and probably had omitted others which must be considered as not without importance in connection with the great progress of Canada. What he had tried to do was to give a general sketch of the subject. He hoped that they had been interested.

TWELFTH ORDINARY MEETING.

Wednesday, March 3, 1897; W. T. Thiselton Dyer, C.M.G., F.R.S., Director of the Royal Gardens, Kew, in the chair.

The following candidates were proposed for election as members of the Society :—

Browne, J. Harris, Hadley Brewery, Barnet.
Coombes, William Henry, 32, Northwood-road, Highgate, N.
Gunter, James, Estate-office, Glasbury, Radnorshire.
Morgan, Herbert, Alderley Edge, Cheshire, and Ducie Mills, Manchester.
Nicholl, William, A.R.A.M., 8, Weymouth-street, Portland-place, W.

The following candidates were balloted for and duly elected members of the Society :—

English, Thomas Matthew, H.H. the Nizam's Mint, Hyderabad, Deccan.
Furse, Alfred C., Montpelier, Brecknock-road, N.
Gardner, Robert, 20, Lloyd-square, W.C.
Lloyd, Thomas, 99, Earl's-court-road, Kensington, W.

The paper read was—

ENGLISH ORCHARDS.

By George Gordon, F.R.H.S.

It would, I am fully persuaded, be not less gratifying to you than agreeable to myself were I in a position to speak this evening in terms of warm praise of the present condition of English orchards, and in a spirit of hopefulness with regard to their possibilities. It would also be extremely pleasant if I could, with strict regard to truth, describe them as having no superiors in any part of the world, and as so rapidly increasing in productiveness as to justify the hope that the time is within a measureable distance when they will yield supplies sufficient to meet the large and increasing demand in this country for fresh fruit. Still further I should be glad to speak of them as so judiciously planned and skilfully managed that they might serve as models for the guidance of colonial and foreign fruit growers. It would not be less pleasant to dwell upon the glorious pictures the orchards present in spring when the trees are enwreathed with their snow-white or delicately-tinted blossoms ; and in autumn when the supple branches are bending beneath their precious burden of fruit, and also to refer to the profit their crops give their owners, and the satisfaction the fruit affords those who have to depend upon the markets for their supplies. Unhappily, most of these pleasures are for the present denied me. Instead of giving expression to feelings of satisfaction with what has been accomplished by owners of orchards, it is my duty to place before you facts which to those not fully conversant with the subject might well appear incredible in the light of the remarkable advance that has been made in all branches of industrial activity during the past half-century. I have, indeed, to bring before you a state of things in relation to the orchards of England, so grave as to deserve the most careful consideration of all who are interested, however indirectly, in the prosperity of the owners and tillers of the land ; and I earnestly hope, as one result of this meeting, that attention will be aroused to the necessity of a drastic reform in orchard management.

The question of fruit culture is one that has for many years received a large share of my attention, and I have endeavoured to keep it constantly to the front, not only in discussing its various aspects in the pages of the *Gardeners' Magazine*, for whose policy and management I am responsible, but, as far as my somewhat exacting professional duties will permit, by work in other directions. Ten years ago I initiated a series of conferences at the Crystal Palace, which were held in conjunction with the autumn exhibitions of fruit, and at the gathering in the autumn of 1890 I submitted a report on the condition of fruit culture in Ireland, this report being founded on investigations that I had made myself, and at my own cost, in the course of the previous summer. The success of these conferences stimulated the Royal Horticultural Society, the Fruiterers' Company, and several of the principal provincial horticultural associations into activity, and as the result of the combined efforts, the area under fruit has been increased during the decade by 18,923 acres, and considerable improvements have been effected in methods of procedure so far as they relate to market garden plantations. With the exception of the first-mentioned society, the several associations appear to have grown "weary of well doing" in the advancement of profitable fruit culture, and have returned to their old methods, and the Royal Horticultural Society has shrunk from grappling with the somewhat difficult question of the orchards. We are, therefore, now in the position of having a continuously-increasing demand for fruit in all our populous centres, with tens of thousands of acres of the finest land in England occupied by fruit trees in so dilapidated and wretched a condition that they cannot possibly pay even the rent of the ground, without one of the several hundreds of societies that ostensibly exist for the advancement of horticulture and agriculture being engaged in making a systematic endeavour to improve their condition. I regret also that, with some notable and praiseworthy exceptions, Technical Education Committees are not less oblivious of their responsibilities in this matter than are the the societies immediately concerned with the affairs of the farm and garden. In proof of this I have only to point to the fact that in counties where the orchards are in a terribly neglected state, large sums of money are annually expended in teaching painting on china, music, dancing, and similar accomplishments, while not a penny, so far as I have been able to ascertain, has been spent on the education of the occupiers of orchards in their management and the utilisation of their products. I would submit that the chief object of societies that profess to foster horticulture and agriculture, and of education committees in counties, should be to diffuse information upon matters having direct relation to the work of those engaged in the cultivation of the land, for not until the cultivator is well informed upon the principles and practice of his art, can he hope to obtain a full return for his labours.

Unfortunately these public bodies do not, as a rule, hold the same views with regard to their duties as myself, and considering it to be utterly futile to expect them to take the initiative in the adoption of some means by which an improvement could be effected in the orchards, I carefully considered what could be accomplished by private effort. As the doctor must diagnose a disease before he can properly prescribe for his patient, it appeared to me that one of the first steps towards an amelioration of the condition of our orchards would be to direct attention to the state of neglect and decay into which they have fallen by means of exact reports founded upon careful investigations. It was accordingly decided to investigate them on behalf of the *Gardeners' Magazine*, and publish the results of the investigations. The task was not one to be lightly entered upon, and I confess that it gave me much anxiety. To be of value the investigations had necessarily to be made in a thorough manner by an expert possessed of keen powers of observation, and also well versed in every phase of fruit culture, and full investigations carried out on these lines over the whole of England could hardly fail to prove very costly. Happily the proprietors of the journal readily consented to the heavy expenditure being made, and I was fortunate in engaging as Special Commissioner an expert possessing in an eminent degree the qualities essential to the proper performance of the duties. The investigations extended over nearly two years, and as the result of these inquiries I have been able to publish full reports upon twenty-four typical English counties. In passing I would mention, as indicating the care and thoroughness with which the investigations were made and recorded, that, although I have received several hundred letters in reference to the reports, in no one instance has their accuracy been called into question. I had previously gone over much of the ground myself, and it was a great satisfaction to me to find how closely my instructions, that the condition of the orchards examined should be described with exactitude and without embellishment, were being followed. One had need have something that will give rise to a feeling of satisfaction in connection with the orchard question, for the record is one that can hardly fail to fill the mind with profound regret. It brings into relief the fact that, while in the whole of the counties fruit is grown in private gardens and in many market garden plantations in accordance with advanced practice, orchards have for the most part been so neglected as to have become a blot upon the landscape and a discredit to their owners. I shall not weary you by reading any considerable proportion of the reports; but to convey an adequate idea of the state of things that now obtains, it will be necessary to give a few short extracts from those on the counties specially favourable to the profitable cultivation of fruit.

As you are well aware, it is quite a common thing to speak of Kent as the "Garden of England," and, so far as our hardy fruits are concerned, it might justly be described as the "Garden of the World," for nowhere can apples, cherries, pears and plums be grown to a higher degree of perfection than within its boundaries. It is a matter of common knowledge that the most advanced practice obtains among a section of the fruit growers of Kent. Yet what do we find? For an answer to the question I must turn to the report on the county: "An orchard of standard apples soon gave me material for survey; the field was one of some twenty acres, and the trees seemed to be about fifteen years old. I was struck by their miserable appearance. In the whole field there was hardly one that looked healthy, and with but few exceptions they were dying of canker, being covered with great gaping wounds and leafless branches. Some were bearing fruit, but in appearance and quality it was of the most wretched description. It will go into the market, of course, stunted, specked, and discoloured as it is, and come into competition with large, fresh-coloured American produce." In the reference to another district we are told "I came upon as instructive an example of how not to do it in fruit growing as could be found in the whole kingdom. A peculiar whiteness on the trees, as though they were silvery wtth a fall of summer snow, attracted my attention, and on getting amongst them I found, as I expected, that they were attacked by American blight. But what an attack! The sight of those trees, thick with heavy masses of the loathsome pest on trunk, limbs, branches, and spurs, will not quickly fade from my memory." Speaking of the common black plum which is so largely grown in some parts of Kent, more especially in the Ash and Sandwich districts, the report states, and I quote it as bearing upon a point to which I shall have to refer later: "We have heard the old story about plums rotting on the trees. We shall hear it again until some of the hundreds of thousands of trees, the produce of which a wise public will hardly buy at any price, are swept away or grafted with sorts that the public want." If we find, in the fair county of Kent, trees dying in consequence of their having been improperly planted or from insect infestation, and of orchards that are unprofitable because they consist of inferior varieties, it is not surprising to find in proceeding westward that the orchards of Sussex, Hampshire, and Dorset are also in a wretched plight. I do not, however, purpose detaining you with extracts from the reports on these orchards.

The four great fruit-producing counties in the West of England are Devon, Hereford, Somerset, and Worcester, and it is in these that the greatest need for improvement exists. These four counties contain about 97,678 acres of orchards, and, notwithstanding the highly favourable character of both soil and climate and the facilities that exist for the disposal of the produce, not one-fourth of this large area gives an adequate return. Here we find not only trees that are unproductive through age, starvation, or some other form of indifferent management, but thousands that, in consequence of the inferiority of the varieties, bear fruit that is utterly useless, excepting it be to make bad cider. In the formation of many of the apple and pear orchards, trees that had sprung from the pips distributed through the medium of the refuse from the cider or perry press were planted, and there they have remained until the present day, giving neither pleasure nor profit to their owners, and without anything being done to improve them by the simple process of grafting.

With regard to the capabilities of Hereford as a fruit-producing county, we are told "almost every holding in Herefordshire could produce magnificent fruit for home use or for supplying the market if the trees were given proper attention and the right varieties grown. The soil is naturally rich and fertile, resting on the old red sandstone in many parts of the county, and the colour of the fruit when ripe is very bright and striking." The manner in which the great natural advantages of the county are in too many instances utilised may be gathered from the following statement in reference to the Leominster side of the county: "With the exception of gardeners, no one appears to trouble much about the orchards, except when the faggot heap needs replenishing. Then the farmer turns his attention to his orchards, and the dead wood is cut out of the trees, with also, it may be, many of the large limbs. I never saw worse mutilated trees than those met with in one or two orchards. . . . Canker, American blight, lichen, dead wood, and general carelessness are only too apparent on almost every side. Young trees that should be producing full crops of the largest apples may be seen in a dying condition, through sheep or young horses having gnawed off all the bark on the trunk. The tree-guards are in many instances of the most primitive description, and practically worthless. Hundreds of young trees are literally choked by a mass of thorns or small branches of forest trees tied up in a bundle round the stems. This rough and ready method certainly answers the purpose of protecting the young trees from sheep, but in a year or two nettles, thistles, and other noxious rubbish grow up amongst this protecting material, reaching almost as high as the trees, excluding all moisture from the roots."

With regard to the orchards in another part of the county, it is stated, "I found on measurement trees only fifteen feet apart, and, as a matter of course, the heads were literally interwoven with each other. . . When the tops get into this very congested state, all the enemies natural to fruit trees hold high revel, devouring foliage, blooms, and even the points of the shoots, until all the food at hand is exhausted. These wasted orchards are a standing menace to other growers who exercise proper care with their trees, as they are practically a nursery for all sorts of injurious pests, which spread and attack other orchards in the vicinity."

As Hereford has long been known for its cider, it follows as a matter of course there should be a reference to that beverage, and, so far as it relates to the produce of the farm orchards, here it is: "There seems to be a general opinion that farmers in Herefordshire do not make such good cider as they did years ago. It is not surprising there should be a decline in the quality of the beverage when, as I had more than one opportunity of seeing, they neither take the trouble to keep the varieties separate when grinding up the fruit, or to throw out the rotten fruit! They in many cases smash sound and rotten apples all up together, consequently the liquor is injuriously affected. More might be stated about the slovenly manner in which some of the farmers make their cider, but the marvel is that men can be tempted to drink the unpalatable stuff. There is no reason why they should not manufacture the most delicious cider and perry, for the county is specially suitable for producing fruits for conversion into these beverages; and I was informed by one of the most successful makers of cider and perry, whose name is familiar, that both are annually becoming more in demand as a summer beverage by all classes." There is, I am anxious to state, much excellent fruit grown for market in the county, and large quantities of cider and perry of the highest class manufactured, but the farmers' orchards are on the whole in a most disreputable condition, and the cider produced is of inferior quality with no evident signs of improvement.

Devonshire has the largest acreage under orchards of the English counties, and consequently the report on the present aspect of fruit culture in this shire has special interest, and no excuse will be necessary for the two quotations I shall make. We are told with regard to the capabilities of the county: "By way of showing what it is possible to do in Devon, I give a few figures supplied by Mr. Snow, who has an orchard only one acre in extent, but which has been thoroughly well-managed from the time it was first planted. In 1893, Mr. Snow grew enough fruit to make 31 hogsheads of cider, which he sold at the rate of 35s. per hogshead. In addition, he gathered and sold 500 score pounds of apples which fetched, on an average, 1s. per score. Good crops were again had in 1894, and 13½ hogsheads of cider were made, this fetching 26s. per hogshead, while no less than 350 score of apples were marketed, this time at 13d. per score. If the old notions were true, to the effect that some varieties of apples only bear fruit once in every two or three years then Mr. Snow ought to have had very few fruit in 1894, and not a very heavy crop in 1895. As it happens, the trees are not in a crowded state, nor individually in want of thinning out, nor of being cleared of moss, nor in need of assistance at the roots, and, as a consequence, they were fully equal to bearing an even heavier crop. Twenty-nine hogsheads of cider were made, and 650 score pounds of apples marketed." The way in which these capabilities have been taken advantage of may be gathered from this excerpt: "Devon is certainly famous for its orchards, and noted for much of the cider that is made in the county; but the orchards will not, as a rule, bear critical examination, nor is cider sufficiently in demand to justify such a waste of space in growing apples for its manufacture. As a matter of fact, Devonshire, compared with other counties, has made little or no progress of late years, and there are hundreds of orchards in that county that are a little short of disgrace to those who own or rent them. Here and there are signs of improvement taking place, and it is hoped the capable instructors engaged by the technical education committees will not expend their energies in vain. The majority of the orchards are rented by farmers, who too often are the worst of gardeners and the poorest of fruit growers, and they cannot be induced to improve on their methods. All the while the trees remain standing, that is sufficient for them, and not a few that have blown over—for they get some heavy gales in Devon—are left where they are as long as life remains in them, or the cattle that roam in the orchards leave them fairly intact."

Much the same state of things exists in the orchards of Somerset, which ranks next to Hereford in the area under fruit trees, and with reference to these, it is stated, "Somerset, all things considered, is one of the most fertile counties I have yet passed through, and in the matter of climate, there is also room for complaint. Yet, curiously enough, several kinds of hardy fruit have to be imported—plums and damsons chiefly from Worcestershire, and cherries from Kent." Also "great areas are devoted to cider apples, which produce heavy crops; but they are of little value, and not until there is an immense improvement in the manufacture and increase in the consumption of the beverage can there be any profit from cider." Worcester has the next largest acreage of fruit, and with regard to the farm orchards, we are told—and this is the last extract from the reports that I shall trouble you with—"In no case did I find the average tenant farmer abreast of the times in the matter of orchard management. These men's ideas are immovable, as their actions are generally confined to the practice of sticking in a tree in the position occupied by one that has fallen into decay. Pruning appears to be quite neglected by them, and the trees, in the majority of cases, are in such an unsatisfactory condition that no possible system now pursued will so restore the fertility of the orchards as to ensure fruit of such quality as can compete in open market with foreign productions." I should like to speak in some detail of the condition of the orchards of Beds, Berks, Bucks, Essex, Cambridge, Leicester, Notts, Norfolk, and other counties, but time presses, and I have already said sufficient to show that the English orchards are, in the majority of cases, in a condition that renders it impossible for the trees to produce fruit worth sending to market, or worthy of the purchaser's attention, should the owner be unwise enough to consign it to a salesman.

It might well be asked at this point whether the possibilities of profitable fruit culture in England are such as to justify a serious attempt to renovate the orchards capable of being brought into a productive state and of replacing those where renovation is practically impossible with new ones. In case this question should be in the mind of any member of the audience I will at once give an answer, and this must be in the affirmative. Assuming fruit to be an important article of food, and a plentiful supply over the largest possible period desirable in the household, it will be readily admitted that it would be very much better for the farm orchard to be in a condition to supply the household with an abundance of fruit during nine months of the year than for the farmer to have on his holding a large number of unproductive trees and have to purchase at the nearest town or village foreign fruit, either fresh, dried, or in tins. This is not the principal aspect of fruit growing, but it is one that deserves the instant attention of both the tenant and his landlord, and also of the several bodies which exist for the encouragement and improvement of rural industries. The most important aspect of orchard management is unquestionably the production of fruit for profit, and with reference to it I have no hesitation in stating that carried out on proper lines it will give a good return. In making this assertion I must not be understood as being in sympathy with those who would have us believe that it is possible to make a fortune in a short time from a few acres of fruit trees. What I submit is that under proper management orchards will be at least as profitable in proportion to their area as any other crop that can be grown. They should give a far greater profit than the best of the farm crops, and add materially to the value of the holding, but it will suffice for the purpose of my argument to submit that while worthless orchards are unprofitable, those in good condition give an ample return for the initial outlay and the expenditure incurred in their management. There are, of course, a large number of both tenants and landowners who are ever ready to contend that there is no profit in orchards, and to declare that "You cannot restore the prosperity of agriculture with a few pots of jam." But these will also tell you that "the farmer cannot be made rich with a few pats of butter or a few fowls," and such catchy phrases may appear to those who have bestowed no thought upon the subject to dispose of the question. Let us see whether the culture of fruit, the making of jam, and the keeping of poultry would, if properly carried out, help the farmer to contend with the difficulties inseparable from the low prices of his staple crops. I shall not trouble you with a large array of figures, but shall confine myself to those found in last year's official returns, as they are quite sufficient for my purpose. These show that the value of imported fruit was £5,540,069, of poultry £605,458, of eggs £4,184,567, and of butter £15,344,083, making the respectable total of £27,256,648. I do not suggest that the whole of this sum could have been retained in this country, but I submit that a very large proportion would have been, had those concerned fully informed themselves in past years as to the possibilities of the demand for these so-called minor products, and the best means of supplying them in abundance, of good quality, and in the most attractive and convenient form. I am now only concerned with the amount we pay the foreign growers for fruit, for the greater part of the supply might, and, indeed, should be produced in our own orchards and plantations.

With regard to apples we imported last year 6,177,192 bushels, of the declared value of £1,582,471, and I submit that a very small proportion of this enormous quantity should have been required from the foreign and colonial orchards. In case anyone may be inclined to question this assertion I will at once state that in no other country are the conditions more favourable to the production of apples of the finest quality than those which obtain in England. For proof of this it will suffice to point to the splendid apples that are produced in gardens where the trees receive proper attention, even in districts that are not particularly favourable to hardy fruits. It is not the soil or the climate that makes us so largely dependent upon the foreign growers for our fruit supplies, but the apathy and ignorance of our cultivators. The lamentable state of our orchards is one proof of this, and the wretched manner in which the principal part of our fruit is placed upon the market is another. Not only is there a want of care in gathering and packing, but fruit is sent to market without regard as to the season, and, in consequence the late apples that may be had in perfection until March or April are sent to market in the autumn with the result that the prices of the early varieties are unduly depressed and the markets are almost wholly dependent upon foreign supplies after Christmas.

In formulating a scheme for the improvement of English orchards it will be convenient to divide them into three groups. The first to comprise those consisting of trees so old and exhausted that their restoration to vigorous health and productiveness is impossible; the second, orchards in which the trees are in robust health but represent inferior varieties; and the third, those orchards which contain moderately young trees of good varieties that have been allowed to become unproductive, through neglect. There is but one way of dealing with the orchards belonging to the first category and that is to sweep them wholly away and replace them with new orchards formed on some other part of the farm. To attempt to renew worn-out orchards by planting young trees in the positions that were occupied by those which have died out, as is so generally done, is worse than useless, for it is a rare occurrence for trees so planted to be of any value as fruit producers.

In dealing with orchards containing healthy trees of inferior varieties, the obvious remedy is to graft them with varieties that are well known for their productiveness and the high quality and good appearance of their fruit. In the western counties, where pears can be most successfully cultivated in orchards, as proved by the remarkable development of the trees of perry varieties, I would suggest that a considerable proportion of the healthy trees now bearing fruit only suitable for the manufacture of perry should be grafted with such excellent varieties as Louise Bonne of Jersey, Beurré Clairgeau, Williams' Bon Chrêtien, Pitmaston Duchess, Beurré Hardy, Doyenne du Comice, Marie Louise, Marie Louise d'Uccle, and Josephine de Malines, care being first taken to ascertain by inquiries made in gardens which of the varieties will succeed in the district. Stewing pears are not less profitable than dessert varieties, for Catillac, Uvedale's St. Germain, and Verulam, which are the best of them, are good bearers, and the fruit is available for the market during a period of six months, commencing with October, and can be sent long distances without special difficulty.

From the apple orchards the hundreds of inferior varieties, whether belonging to the table, cooking, or cider sections, should be swept away and replaced with others that are sure bearers and produce fruit of good appearance and high quality, and of these there is an abundance. I would advise also that the area devoted to cider orchards, which in the western counties form, it is computed, about four-fifths of the whole, be reduced by grafting the trees occupying many thousand acres with dessert or cooking varieties. Cider is an excellent beverage when properly made, but we are now concerned with making the orchards as profitable as possible, and it is obvious that apples worth from £10 to £20 per ton are more profitable to grow than those which will not realise more than from £1 to £5 per ton. It is also evident that to obtain a full return from their orchards farmers must grow both late and early varieties, and adopt some inexpensive method of storing the fruit of the former until after the early supplies have become exhausted. The most profitable of the cooking varieties are Bismarck, Ecklinville, Dumelow's Seedling, Gascoyne's Scarlet, Golden Spire, Lane's Prince Albert, Lord Suffield, Newton Wonder, Potts' Seedling, Tower of Glamis, and Warner's King. Then of the dessert varieties I would recommend Blenheim Pippin, which is slow in coming into bearing when planted as an orchard standard, but grafted on large trees it quickly becomes productive, and the fruit, by reason of its handsome appearance and high quality, invariably commands a good price; Cox's Orange Pippin, one of the most profitable of dessert apples in districts favourable to it, and when the fruit is properly marketed; Duchess of Oldenburg, an early variety which has a short season; Devonshire Quarrenden, useful for planting within a short distance of the market; King of the Pippins, and Worcester Pearmain. These form but a small proportion of the apples in the catalogue, but before we can make our orchards profitable we must follow the example of the American growers, and instead of planting two or three trees each of a hundred varieties, we must plant a hundred trees each of a few varieties, and these of the very best.

Better selections of plums are also much needed, and owners of orchards will be wise in making an endeavour to extend the season as far as it is possible to do so by growing more early and late varieties. A good selection for orchards would comprise Rivers' Early Prolific, the Czar, Greengage, Pond's Seedling, Victoria, and Monarch. I do not propose discussing the details of grafting, but I would strongly advise that, instead of the trees being headed back to the trunk or to the base of branches, with a diameter of 6 or 7 inches, in accordance with the practice that largely obtains, they should be simply cut back to the smaller branches not exceeding 2 or 3 inches in diameter, and a graft placed on each shoot. Not only will the union be more perfect when the smaller branches are grafted, but there will be a considerable saving in time, as fruitful heads will be obtained in two or three years.

In the renovation of the orchards that have become unproductive through bad usage, attention should first be directed to the restoration of the vigour of the trees. The heads should be thinned by the removal of useless spurs, and the cutting back of weakly branches; and when this has been done, spray the trees with warm water, in which has been dissolved caustic soda and commercial potash at the rate of 2½ lb. each to twenty-five gallons. The mixture, applied in the form of a spray during the winter season when the trees are dormant, will clear them from moss and lichen, and destroy the eggs and larvæ of some of the insect pests. If the trees are infested with American blight, as, unhappily, too many of them are, means must be adopted for the eradication of the pest, and there is not a better method than to dress the infested parts with a mixture prepared by dissolving ½ lb. of carbolic soft-soap in a gallon of hot water, and then adding one pint of petroleum, and well incorporating it while hot. As the starved condition of the trees is necessarily due to the impoverished state of the soil, it follows as a matter of course that the soil should be enriched, and that the admission of air to the roots be increased for the purpose of stimulating them into activity. There is no better course of procedure than to break up the surface of the soil to a depth of three or four inches in the autumn, and dress them with lime; and early in the spring apply a liberal dressing of natural or artificial manure. Farmyard or stable manure should be used where available, and if this is not at command, use artificials. An excellent mixture of these would be one consisting of three parts by weight of muriate of potash to five parts of superphosphate of lime, and 8 cwt. per acre will be a good rate at which to use it. A liberal dressing of soot will be also beneficial, as would a dressing of nitrate of soda at the rate of one cwt. per acre, after the trees have commenced to make new growth. The breaking up of the surface soil as here advised will have a highly beneficial effect upon the trees; and I would mention that while excellent crops may be obtained from grass orchards, it is only by cultivating the spaces between the trees that the finest fruit can be obtained.

I might speak at length on grading, packing, and marketing, for the owners of orchards have much to learn before they can achieve success in carrying out these important details, but I am anxious to avoid unduly taxing your time. The question of storage is also of pressing importance, and I would strongly advise that in connection with all orchards of any considerable extent there should be a spacious store-room. This need not be elaborate in detail or costly in construction, but it should be substantial and so designed that a low and uniform temperature can be maintained throughout the winter. It ought, in fact, to be heat-proof and frost-proof. A span-roof structure about twelve feet in width and ten feet or so in height, and fitted with open shelves on either side will perhaps be the best form of structure, and if it be provided with double walls, double windows, and double doors, and a thick roof of thatch, the fruit will have the advantage of a cool and equable temperature. It is not without considerable regret that I have to dismiss the question of storage thus briefly, for it has an important bearing upon the profitableness of our orchards. In conclusion, then, the owners of orchards have generally speaking not only to learn how to restore their orchards to fruitfulness and maintain them in that condition, but they must learn also to store the produce until such times as they can place it upon the market with most profit to themselves. The owners of English orchards have certainly much to learn and much to accomplish before the 212,000 acres devoted to fruit can be brought into so fertile a condition as to enable them to compete successfully in their own market with foreign and colonial produce, as they should assuredly be able to do, for in no other part of the world do growers of similar kinds of fruit to those discussed, namely, apples, pears, and plums, enjoy greater natural advantages.

DISCUSSION.

The CHAIRMAN said he regarded this paper with peculiar satisfaction, because, some time ago, he had drawn attention to the extremely large amount of horticultural produce imported into this country from abroad, and instead of meeting, as he had expected, with sympathy, he was attacked on all sides. Still the fact remained, and, in trying to ascertain the reason for it, he came across economic problems of considerable complexity, but he was disposed to think that one of the most important factors was the question of distribution, under which he included markets as well as freights. It seemed to him extraordinary that if you wanted a decent apple, at any rate in the neighbourhood of any large town, you had to pay about 2d. for it. A whole evening might well be devoted to the apple alone, and there was quite a chapter of historical and anthropological romance connected with it. He would not speak of the calamities traditionally attributed to its first appearance in human history, but it was a curious fact that though it came from the East, it was from those unhappy highlands, the mountains of Asia Minor, which now engaged so much attention, and it seemed to have been distributed in Europe mainly by the energies of the Teutonic race. England being as it were the last term of the Teutonic migration, we were now in possession of a country where the apple, he quite agreed, had reached its highest standard of excellence. He did not believe any spot on earth could produce fruit which would compare with the old Ribstone Pippin, the Blenheim Orange, or Cox's Orange Pippin, which was a descendant of the old Ribstone stock. The apple of the Bible was, of course, only such by a misuse of language, there being little doubt of its being a quince. Curiously enough the Latin races had done very little with the apple; neither in France, Switzerland, or Italy were apples much appreciated, and hardly anyone but a schoolboy would venture upon them. Having then, possession of the apple, it seemed marvellous that we could not make more of it, and everyone must agree that anything which would extend the cultivation and distribution of this admirable fruit at a moderate price was much to be desired. Mr. Gordon seemed to throw the whole blame on the cultivator, but from a somewhat varied experience he was more and more impressed with the fact that you could not induce people to take up any industry unless you showed them that they could make—not a fortune, but a reasonable profit out of it. If there were that demand for fruit on the part of the public which he should like to see, he did not believe the farmers were so perverse that they would not try to meet it. Where the matter hung fire would perhaps be elicited in the discussion, but in any case they were much indebted to Mr. Gordon for the trouble he had taken in setting on foot an inquiry of his own, the results of which were as valuable as many Blue-books. He had collected an important body of facts, and it now remained to see how they could be dealt with. His own small experience bore out what had been stated, for in the Severn Valley ke knew of square miles of orchards which were completely covered with lichen, and produced far more misteltoe than apples. With regard to the intermittent bearing of fruit trees, a very interesting explanation had recently been attempted, and it was asserted that when an orchard was planted with different kinds, it was more fertile than if only one variety were grown. He believed this had been shown to be the case, and it certainly might have been predicted on scientific grounds. He feared Mr. Gordon was not quite so sympathetic on the question of cider as could be wished. He well remembered as a child being fascinated by the various domestic industries which were carried on in an old country house—his grandfather's—where they made not only their own butter, but their own cider. Very excellent beer was also brewed, and his grandfather was particularly proud of manufacturing a really palatable wine. The extension of railways, the production of goods on a large scale, the varied conditions of labour, and other changes had entirely obliterated these individual industries, and in doing so had robbed country life of a great deal of its simple charm, for living in an old country house forty years ago almost represented the kind of life depicted in the Georgics. Though cider was not now made as it then was for domestic consumption, he hoped one result of this paper would be to give encouragement to its production. He had the pleasantest recollections of it as a beverage during his university life, when it was generally preferred by the undergraduates to any kind of beer, and he was surprised to hear of the decay of the industry. He thought it would be extinguished with great difficulty, and would spring up in some fresh place where it was least expected. Not long ago, when dining with a Member of Parliament, he remarked on the excellence of cider made in Norfolk, to which his friend, who was of rather a positive turn of mind, replied that no cider was made in Norfolk. Happily, having a considerable store of cider in his house, with the name and address of the maker, he was able to convince his friend, who was a Norfolk man himself, that his county produced cider of which no one need be ashamed.

Mr. C. W. Radcliffe Cooke, M.P., said he agreed with the Chairman that, admirable as the paper was, Mr. Gordon was a little hard on the cider industry. It was true that the orchards in Hereford, as well as those in Devon and Somerset, had been much neglected, and he could recognise in the description which had been read, some in his own neighbourhood; but he believed a little improvement had taken place already. Great public interest had been excited in fruit culture in all those counties, and, to some extent, that had been aroused by the increasing popularity of cider. He knew something of this matter, for having become known as an advocate of the beverage, he had received, not only from all parts of England, but also from the colonies, and, indeed, almost all parts of the world, an amount of information which had largely increased the little knowledge he had before. But he must say that the more he knew of the subject, the less he felt inclined to speak upon it, because the more difficult he found it to be. Within the last three or four years, the industry had increased enormously, and he found the popularity of the beverage was extending in quarters where formerly it was never heard of. He could not agree that it would be more profitable to grow pot fruit and dessert fruit than cider fruit. An instance was given of a man in Devonshire who sold his apples at 1s. a score pounds, which was about 2s. a bushel, which would be only 30s. for 15 bushels; but if made into good cider, worth 1s. a gallon, they would have produced £2 14s. He could show from statistics that the price paid by the consumer for the produce of an orchard converted into cider was much above that paid for pot or dessert fruit to the owner of a similar sized orchard. This view, therefore, as to the renovation of English orchards differed somewhat from that given in the paper, which proposed that a number of the cider and perry producing trees should be beheaded and grafted with other kinds. There was plenty of unoccupied space on which pot and dessert fruit could be grown; and he would rather suggest a return to the ancient plan of planting orchards with both kinds, good table fruit and also good vintage varieties, some of which had almost gone out of cultivation, but might be revived. There would always be variations in the yield, and some years there would be a glut; when, whatever the demand, the fruit could not be sold at a remunerative price. In 1895 for instance, an enormous quantity of fruit in Kent wa spoiled, and one gentleman wrote to him saying that, if they could only have stored the fruit (which was rotting on the ground) in a liquid form, they could have kept it for years, and sold it when profitable. His suggestion was to plant a sufficient amount of vintage fruit, so that when necessary it could be utilised, in conjunction with the other kinds, to make cider which would keep. Cider could be made from dessert or pot fruit, but without a certain proportion of tannin, such as was supplied by the vintage kinds, it would not keep. A few days ago he was present at an interesting celebration at Eynsford, in Kent, where through the energy and enterprise of one gentleman, Mr. Till, it was resolved to commemorate the Diamond Jubilee by the establishment of an Arbor day in England, such as was well known in America, Canada, and other countries. All the school children had a holiday, and a number of trees were planted, some ornamental, and some fruit trees. This annual holiday was inaugurated on Saturday, at Eynsford, when Sir George Birdwood planted a tree; he planted one, and altogether about 150 trees were planted, a good proportion being vintage apple trees, because in the parish the cider industry had been lately revived. Not only Norfolk, but Kent, Essex, Sussex, and Surrey also, were cider counties years ago, and Mr. Till had now restored the industry. In 1895 he sold 8,000 gallons, and last year a great deal more of very fair quality, and when he was able to introduce the proper vintage fruits it would be quite equal to Hereford. Although they were much indebted to Mr. Gordon for his investigations, he thought they ought to go a step farther, and ask for a Government Commission to thoroughly investigate the subject and present a report which would be authoritative and might, if necessary, form the basis of legislation for insuring the occupier a more certain return for his outlay, or for the repression of insect pests. In Tasmania, and he believed in other colonies, a law was passed requiring the owners of orchards to keep them clean and healthy, with penalties on disobedience. Then it was desirable to ascertain the best kinds of fruits, which required long and careful inquiry, and involved an expenditure which no private individuals could be expected to undertake, not even nurserymen. We should hope too, that if a Commission were appointed, it would recommend the establishment of experimental fruit farms, where budding, grafting, and investigations on different varieties of fruits could be carried on, and also of local nurseries from which growers might be supplied with the best kinds of trees. Fruit trees always did better when the nursery from which they were taken was in the neighbourhood of the land on which they were planted. At the meeting at Eynsford on Saturday two resolutions were passed unanimously, which he endorsed, one recommending the appointment of a Commission to inquire into the condition of orchards throughout the kingdom, and the other recognising the importance of encouraging the planting in Kent of vintage varieties of apples, such as were formerly grown there, and the introduction of prime cider fruits, many of which were also excellent keepers and cookers. The question of distribution affected cider as well as apples, and he was pleased to say that owing to the action of the Cider Makers' Association the Great Western Railway had resolved to reduce their rates from March 1st, and it was hoped that the Midland and London and North-Western would follow suit.

Sir GEORGE BIRDWOOD K.C.I.E., said he could not but think that our present marked incompetence to compete with foreign producers in our own markets was due to the thriftless habits of our people, and their incorrigible obstinancy. As an illustration of this he would mention a case which recently came under his observation in one of our northern manufacturing towns. The chief man in the market of the town was a hale old man of over 70 years of age, who lived five miles away, and had a railway station close to his farm, had never used the railway to bring his produce to market, and had actually never turned his neck round to look into the railway station of the town, though the back of his stall in the market adjoined it. How could you expect people with such ingrained obstinacy to keep up with the times. During the 25 years he had resided in England he had done all he could in his small way to encourage local industries, and he tried to get his butter, eggs, and poultry, and cheese and fruit from the farmers of the neighbouring counties, but what was the result? Week after week the butter was never twice the same, either in colour, taste, shape, or weight of the pats; the poultry came untidy, unclean, and positively repulsive looking, the cheese was never uniform in quality, and the fruit unripe, bruised, and half rotten, and quite unfit to eat.

Mr. ALEXANDER DEAN said the County Council of Surrey, under which he was horticultural instructor, had at least done something to instil into the minds of the people of that county some better idea of the importance of fruit culture than seemed to have existed in the past. He did not at all agree with the idea which seemed to be uppermost in the mind of Mr. Radcliffe Cooke, that the principal use of apples was for making cider; on the contrary, he thought the object of the paper was to show how fruit could be supplied for the purpose of food, rather than for the manufacture of cider, which in his view was an admirable method of destroying all the good qualities the apple contained. Not long ago he was invited to visit a large estate in Gloucestershire and give the tenants some information as to the right method of dealing with their orchards. He found them in much the condition described in the paper, and had to instruct the labourers on the estate how to cleanse the trees and bring them into a productive condition. The owner was a gentleman who took great interest in these things, and he invited a number of his tenants to a meeting in the school-room, where he (Mr. Dean) gave a lecture on apple culture. The general idea seemed to be, not how to get fine fruit, but simply to get a large crop which could be knocked off the trees and laid in heaps for a time, and then converted into the stuff they called cider; and he had to tell them that in that sort of thing he took no interest. The enormous quantity of fruit imported and sold showed there was a great demand for this kind of food, and it was for this purpose orchards required to be improved and fresh trees planted. A gentleman, in another county, wrote to him saying there was no doubt great indifference on the part of farmers, but they could not afford to undertake such a radical change in their orchards, though some did realise the value of good table fruit, and were introducing good varieties; but the landlords seemed also afflicted with the same indifference, and failed to do what they easily could in the matter. He therefore, in the lecture he gave in Gloucestershire, suggested that it was the duty of a landowner to have a nursery on his estate, where he could grow trees to supply his tenants, and he was glad to say that the landowner who was in the chair adopted the idea at once, but he said there ought to be some reciprocity on the part of the tenants, in the shape of a determination to attend properly to the trees when they had them. With that of course everyone must agree. If landowners would adopt this course, as had been done by Lord Beauchamp, with very great success, much good would be done, much more than by the establishment of an Arbor day, which might be a pretty plaything, but also lead to many things which those interested in fruit culture would regret. The question of keeping trees clean was of great importance, and it would be useless for one man to cleanse his trees if he were surrounded by orchards infested with insect life. He hoped the time would come when local authorities would not only be empowered to make regulations on this subject but also to keep implements and material for use within their district, so that the matter should be vigorously and completely carried out. By such measures he thought there was good hope of a plentiful supply of fruit being grown in England equal if not superior to any which came from the United States or the Colonies.

Mr. H. C. STEPHENS, M.P., said he should have been glad if more could have been said on the question of the storage of fruit. One of the greatest difficulties was that fruit nearly all came at one season of the year, and as a rule the grower had to throw it on the market, and take what price he could get at the time. The greatest ignorance prevailed with regard to the storage of fruit; it was useless to ask an architect about it, or even a nurseryman or fruit grower; each man had his own method, and no recognised principles seemed to have been established. It must be perfectly easy to keep an apple like Cox's Orange Pippin in good condition, not only for a few months, but for six years, if necessary, just the same as meat could be kept. It was recognised that the English soil and climate would produce the finest apples in the world, and yet our growers were to a great extent driven out of the market, and last year enormous quantities were imported from the Antipodes. It certainly reflected no credit on English orchard owners that they should be defeated in that fashion. If the Royal Commission, which Mr. Cooke had so much faith in, were constituted, it would certainly be well for this point to receive attention.

Mr. J. S. DYASON said a very interesting discussion recently took place at the Society of Engineers on the question of cold storage in connection with meat, when it was shown that, under a new system recently adopted, fruit had been brought from the Antipodes in such fine condition that it could not be distinguished from English. The system was described as one of insulation, different chambers being kept at various temperatures such as would best suit the articles stored in them.

Mr. GORDON, in reply, said he enjoyed cider as much as any one, but the main object of his paper was to show how the profits obtained from orchards might be improved, and he did not think the manufacture of cider was the best or only way of doing so. In a paper by Mr. Radcliffe Cooke at the Royal Horticultural Society last autumn, he put the return as 300 gallons of cider per acre, and the price at 5d. per gallon which would come to about £7, which he (Mr. Gordon) regarded as a very small return from an acre of apple trees. If properly cultivated it ought to produce five or six tons of fruit, and if of good quality this would realise from £10 to £15 or £20 according to the state of the market. Attention should undoubtedly be paid to the kind of apples grown for cider-making, many of them being practically worthless. With regard to intermittent bearing that arose from neglect in cultivation; if proper nourishment were supplied, the tree would bear a good crop annually. He could quite understand that in 1895 the Kentish growers lost heavily from the glut; but that arose in great measure from the habit of growing almost exclusively early varieties, instead of having some of a later kind, which could be stored and sent to market later in the season. In the winter of 1895-6, although there was an enormous quantity in November, it was very difficult to buy English apples in London after January. This year this was not so marked, but that day he had spent some hours in finding out what apples were in the market and had brought a sample with him. The grower could only have got a very small price for some of these, perhaps not enough to pay carriage, for they compared very unfavourably with the American apples with which they had to compete. On the other hand, he had brought specimens of English apples, which were quite equal in appearance to anything from abroad, and in fact better, so that they could be stored if desired. He had no objection to a royal commission, but would strongly advise owners and cultivators, instead of waiting for its appointment, to set to work at once in the manner he had pointed out.

The CHAIRMAN then proposed a vote of thanks to Mr. Gordon, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

GERMAN BOARDS OF ARBITRATION FOR MERCHANTS.

A matter of more than ordinary interest has recently been before the German business world. An effort is being made to establish Boards of Arbitration for merchants somewhat similar to those already operating successfully in settling the disputes between workmen and their employers, or between workmen themselves. The United States Consul at Chemnitz says that the various Chambers of Commerce, Boards of Trade, &c., have gone into the subject so far, that good, in his opinion, is sure to come from it. The idea originated with the Prussian Minister of Commerce, Baron von Berlepsch. He sent a circular letter to Chambers of Commerce urging the adoption of arbitration. The fact that such bodies have been very successful among manufacturers and their workpeople, keeping the latter almost entirely from the Courts (disputes almost invariably being settled by arbitration) commends them for commercial and trade disputes. Besides an enormous saving in time and money, they yield a much higher per-centage of exact justice, for they are always made up of men familiar with, and skilled in the kind of questions that come up for settlement. The matter has made headway so far, that six Brunswick Chambers of Commerce have established such a Board, to which commercial and trade disputes are to be referred. They have as yet no power to pronounce and execute sentence. Their powers are limited to effecting, if possible, amicable settlements. This failing, parties may still seek justice in the ordinary channels of law. It is agreed, however, that in cases where both parties ask for and agree to submit to any Arbitration Board's decision, such will be given. The great advantage of course to be derived from such Boards is the immense saving of time and money. Consul Monaghan says:—"Arbitration by experts, by men capable of sifting and weighing evidence, by men much more familiar with all phases of commercial problems than any civil Judge ever could be, is sure to commend itself to any community where the ends aimed at are strict justice and as little interference as possible with the course of trade. Even so limited a system as that adopted by the Brunswick Boards, which goes only the length of considering the pros and cons, and then urging amicable settlement, leaving to the Courts the power to punish or compel settlement, has much in its favour. Earnest efforts are to be made to further this movement. The public press commends it, the merchants, manufacturers, and even the lawyers speak of it as a system suggested by common sense; as the only one likely to successfully aid in rapid settlement of cases that crop up in the course of commerce and trade, and that result from misunderstanding oftener than from any desire or purpose to deal unfairly or to do an injustice."

THE WORLD'S GOLD PRODUCTION.

Although no complete statistics are at present available with regard to the production of gold last year, all the information that is obtainable tends to show that the increase has again been a considerable one, though perhaps actually and relatively less than that of 1895 over the preceding year. For example, the *Engineering and Mining Journal* of New York has lately published its annual estimates of the world's output of gold during 1896, and has obviously been at pains to ensure accuracy, so far as that is possible without the full official returns as a basis of the calculations. According to these estimates the production has been as follows in the past two years:—

	1896.		1895.
United States	£11,400,000	..	£9,366,000
Africa	9,050,000	..	8,909,000
Australasia	8,742,000	..	8,559 000
Russia	6,320,000	..	6,356,000
Mexico	1,398,000	..	1,120,000
India	1,200,000	..	900,000
China	1,034,000	..	930,000
Colombia	620,000	..	637,000
Brazil	496,000	..	446,000
Guiana (British)	437,000	..	434,000
Do (French)	375,000	..	373,000
Germany	478,000	..	471,000
Austria-Hungary	366,000	..	366,000
Other countries	1,784,000	..	1,354,000
	43,700,000	..	40,221,000

For the past year, therefore, it is computed that the value of the gold produced exceeded that of the previous year by nearly £3,500,000, while as compared with 1894, the excess is placed at £8,700,000. But our New York contemporary places the production of gold in America at a considerably higher figure than what is given as the forthcoming estimate of the Director of the United States Mint, the latter calculating upon a total of £10,300,000. In the one case an increase of over £2,000,000 is assumed; in the other it is put at but little over £1,000,000; but the difference is probably to be accounted for by the inclusion of the ores brought from abroad in the estimates of the *Engineering and Mining Journal*, whereas the Director of the Mint credits the countries whence the ores were obtained with their gold-contents. It seems probable, however, that the value of the aggregate output of gold last year was fully £44,000,000, of which total the four chief producing countries—the United States, Australasia, South Africa, and Russia—yielded about 80 per cent. It may be noted in passing that the output of gold last year exceeded by about £7,000,000 the total value of both the gold and silver produced in the years 1866-73, before the price of the "white metal" began its downward course, and that as recently as 1888 the value of the gold and silver produced throughout the world did not exceed that of the gold only obtained last year. In the interval the Rand mines have augmented their output of gold from year to year, until it has reached a value of about £8,000,000, while Australasia, Mexico, India, and China have contributed more or less considerably to the steady growth in production all the world over.

When the first important spurt in the new supplies of gold took place a few years ago, there was a good deal of talk about the possible effect of the increased production upon the prices both of commodities and securities; but no such result has yet made itself apparent. For one thing, it is to be remembered that a large proportion of the new supplies, those from the Transvaal, for instance, have practically been retained at their source, the bar gold shipped having been paid for in sovereigns, which have circulated throughout the country in paying wages and obtaining stores for mining operations. It is noteworthy, too, that the stocks of gold held by some of the principal European banks instead of increasing have diminished during the past year. The Bank of England, for example, parted with about £10,000,000 of its stock of bullion, the Bank of France lost nearly £2,500,000, the Bank of Germany about the same, and the Bank of the Netherlands nearly £1,000,000; but these reductions are more than accounted for by the addition of over £16,500,000 to the holding of the United States Treasury, from £10,750,000 at the end of 1895, to £27,349,000 at the end of last year. The New York Associated Banks have also added about £2,000,000 to their stocks of gold. Then, there has been a large accumulation of gold in the Austro-Hungarian Bank, amounting to nearly £6,000,000, in connection with the resumption of gold payment; while by far the biggest accumulation has taken place in the Bank of Russia, which, while it held only a little over £79,000,000 in gold at the close of 1895, had increased its total to £103,671,000 at the end of last month. The enormous increase in the Russian stock of gold has not, it is true, been altogether drawn from current production, because a certain proportion consists of gold previously held by it on account of the Russian Government, which now figures in the Bank return as a backing for the note circulation. But without seeking to trace the distribution of the augmented production too closely, the fact is that this large increase in the output of gold has produced very little appreciable effect, mainly for the simple reason that with such enormous accumulations of the precious metal throughout the world, an increased production of three or four millions a year is, relatively, a small matter.—*Economist.*

Correspondence.

BARSI LIGHT RAILWAY.

May I be permitted to point out with regard to Mr. Calthrop's paper on the "Barsi Light Railway," that his comparative table on page 247 of the *Journal of the Society of Arts* should be taken with some reservation. Mr. Calthrop gives the cost per mile of the different gauges. It should, however, be remembered that there have been constructed standard gauge 11,215 miles, metre gauge 7,903 miles, and special gauge 267 miles. Moreover, the greater portions of the special gauges are in Kathiawar or Northern Bengal, which are flourishing districts. When 5,000 miles of special gauge lines have been built and the average cost is proved to be only £2.000 per mile, and there is a return of 7 per cent. for the money invested, then indeed there will be a boom for these shares in the London market, and a considerable premium will, no doubt, be demanded. Again, in the Director-General of Railway last report, page 102, we find—

	Earnings per train mile. Rs.	Working expenses per train mile. Rs.
Standard	2·31	1·94
Metre	1·63	1·55
Special	1·57	1·79

from which it will be seen that the figures are not in favour of special gauges.

Mr. Calthrop deserves every praise for the unusual pertinacity with which he has stuck to his project for eight years, working out the details and seeing the job through to completion. He will now, no doubt, reap the reward of his labours.

It is easy to be wise after an event, but it is scarcely fair of Mr. Calthrop to censure the Government of India for not appreciating "the certainty of the linking up of the European and Indian railway systems which are now on the threshold of events." Did any English engineer or statesman ever foresee the future development of traffic in this country? Without being a pessimist one might safely lay long odds that "the threshold of events" will not occur within a generation, or say A.D. 1930. We have been ten or twelve years getting to Kandahar, and have suddenly stopped short 100 miles of that place; when we do get there—by-and-bye—there will only be political reasons for going further into a difficult and inhospitable country, till we join the Russian railway system in Central Asia. As to the scheme for crossing Northern Arabia by a railway from Suez to the Persian Gulf, we must wait till an engineer has reported on the route, for at present that region has only been traversed by Lieut. Palgrave, a Bombay military officer.

J. W. PARRY.
Late Executive Engineer.
Indian State Railways.

The Jungle, Anerley, Feb. 22nd, 1897.

Mr. W. R. S. JONES writes:—If I may be permitted to add a few further remarks, I would say that Mr. Calthrop did well to follow the best known modern practice, thus securing an average load of three tons capacity for one ton of tare in his goods vehicles. With the aid of the excellent and ample statistics of the operations of Indian railways, referred to in this paper, I have, by exhaustive investigations, convinced myself and others that, in the whole range of railway economy, there is no subject of equal importance to that of light vehicle stock. In a paper read at the Institution of Civil Engineers, in 1876 (vol. xlvi.), Mr. William Adams showed that, if the Midland Railway Company would reduce the weight of their six-ton wagons from 4·75 tons to 3·75 (his own practice), the reduction of one ton of dead weight per vehicle on the 69,000 traders' and company's vehicles employed in working the traffic of that railway, each vehicle doing 200 miles duty per week, would result in a saving of 717,600,000 ton miles of unnecessary dead haulage per annum. Amongst the many English railway experts who joined in the discussion which followed, the late Mr. Findlay (then general manager of the London and North-Western Railway) disclosed the net cost of working fully loaded trains of coal from Wigan to London. Transposed, his figures result in an average cost of 99 pence per 1,000 gross ton miles, as the cost of haulage on his railway. Subsequently (1891), his book on the management of an English railway contained another useful fact, namely, that to deal with the immense traffic of the London and North-Western Railway 56,000 wagons belonging to the company, and an equal number of traders' wagons, were required—total 112,000—mostly of 7 tons capacity; probably, on an average, weighing 4·75 tons per wagon. If we may take the above data as approximately correct, we can estimate various money values relating to the advantages accruing to reductions of weight in goods and mineral vehicles; for instance, the reduction of dead haulage on the Midland Railway, named by Mr. Adams 717,600,000 ton miles, equals £281,000, which would have contributed an extra dividend on the ordinary share capital of the Midland Railway, in 1876, of nearly 1½ per cent. According to the Board of Trade returns, the goods vehicle stock on the London and North-Western Railway, in 1892, stood at the figures named by Mr. Findlay in his book dated 1891. Now, if the recent practice advocated by Mr. Calthrop (applicable to all gauges) obtained on the London and North-Western Railway in 1892, there would have been a saving of 274,000 tons of goods and mineral vehicle dead weight for the same carrying capacity; and as each ton is estimated to travel 10,000 miles per annum, other conditions being the same, the haulage saved would be 2,740,000,000 ton miles per annum, valued at £1,130,000 odd, which would have contributed an extra dividend of 2·89 per cent. on the ordinary share capital of that date. Further, the average gross earning capacity of a seven-ton wagon does not appear to exceed £60 per annum; and the cost of one ton of dead weight in a vehicle, or vehicles, costs £4 2s. 6d. per annum in haulage. Comparing one of the last items of the above with ordinary Indian railway practice, although the average rates received per ton mile is but 40 per cent. of those obtained in England, seven tons of capacity earns a maximum of £295, whilst the average for all gauges amounts to £110·25 per seven tons of capacity per annum (when converted into sterling at 15 pence per rupee). The length I have travelled in these remarks, only touches the borders of the advantages accruing to the adoption of light vehicle stock on railways, but even from this cursory review, we are justified in concluding that unnecessary dead haulage on English railways to the value of many millions sterling per annum might be saved by the adoption of the practice followed by Mr. Calthrop.

INCREASE OF FLOODS.

It is probable that floods are on the increase, and an enquiry, which would be interesting and useful, as to their frequency, might elicit that it was greater now than some years since. Again, they are seriously affecting the country. This is an important matter, and, with the progress of knowledge, ought to be lessened, like widespread diseases. I have thought it might, therefore, be useful to raise the subject, that its cause might be discovered. If floods are more frequent, why is it? It is, in that case, very needful to apply the remedy, and that the fact be dealt with. To this end, it needs first to decide their occasion.

I just throw out, for specialists' attention, the idea that their frequency and extent may be caused actually, by our knowledge—as every good has some attendant or consequent inconvenience. And I ask those who are conversant with such things whether the trouble may be due to (1) the widesprea irrigation and (2) diminution of forests?

The two questions, I conceive, well deserve attention, and are both before us: Whether flood are becoming more frequent and extensive? and What can, and should, be done to avert them?

CHAS. FOX, M.R.C.S.

Notes on Books.

THE COMMERCIAL ORGANISATION OF FACTORIES A Handbook for the use of Manufacturer Directors, Auditors, Engineers, Managers, Secre taries, Accountants, Cashiers, Estimate Clerk Prime Cost Clerks, Bookkeepers, Draughtsmen Students, Pupils, &c. By J. Slater Lewi London: E. and F. N. Spon.

Mr. Lewis, persuaded as to the waste of time cause by the want of a recognised system of accounts f the student to learn, and the schools to teach, h elaborated one, termed by him the interlocking sy tem, under which each and every account in a engineering factory is brought into line monthly, an a general balance of the whole effected. The system is formed from the point of view of an organiser and manager rather than that of a professional accountant, and it therefore goes to the very root of the proper organisation of a factory. The author writes: "It is frequently assumed, even by persons of presumably extensive experience, that it is sufficient to merely deal at wide intervals with the results of trading as a whole. No mistake is more fatal, as will be realised when manufactory accounts are considered merely in the light of aids to the proper government and control of the organisation. This is entirely distinct from their value as financial and trading results, which can be obtained by other and simpler means."

Mr. Lewis specially points out the need of attention being directed to the question of staff precedence. "It is imperative that every member of the staff should have a clearly defined position, and be given to understand in unmistakeable terms to whom he has to look for orders, otherwise continual bickering and consequent disorganisation will inevitably occur." Chapters 1 to 7 deal with the duties of the following officers:—The directors, the manager, the secretary, the auditor, the accountant, the cashier, and the correspondence clerk; and the subsequent chapters are devoted to other divisions of the work of a factory, such as suppliers' and customers' orders and invoices, drawing office, estimating, stationery, advertising and catalogues, the works' manager, the inspector, the entrance-gates and the gatekeeper, the stores and storekeeper, the warehouse and warehouseman, carriage, the foreman, the timekeeper and job clerk, the paying of wages, establishment charges, stock surveys, diagrams and curves stores, balancing of accounts, depreciation of plant and buildings, salaries and expenses, pupils, apprentices, &c.

The book is fully illustrated by diagrams, and there are two separate ones—A, manufacturing accounts; B, balance-sheets. This large volume deals with so many matters of detail, that a full index is a necessity, and this has been added.

FUEL AND REFRACTORY MATERIALS. By A. Humboldt Sexton. London: Blackie and Son.

The subject of Fuel has been extensively treated by Dr. Percy, as it forms the first volume of his classical work on Metallurgy, and there are of course many other excellent works dealing with the subject. The absence, however, of any compendious text-book has, as Mr. Sexton states in his preface, induced him to prepare the work under review. It is intended mainly for students, but also for engineers and others requiring practical information on the subject.

The subject appears to be treated thoroughly and with considerable care. After a brief account of the theory of combustion, the author discusses the heating power of various fuels; and, after dealing at some length with solid fuels, proceeds to liquid and gaseous fuel. Under the last-named head the regenerative furnace is very fully described, and under the previous one various recent methods for burning liquid fuels. A chapter is devoted to furnaces for metallurgical purposes, and such subjects as air supply, recovery of waste products, prevention of smoke, are also dealt with. Chapters on pyrometry, calorimetry, and testing are given; and a final chapter treats of refractory materials, bricks, and crucibles.

A partial bibliography is given in an appendix with references to papers dealing with special points referred to in the text of the book. The work is fully illustrated, numerous figures being given of such subjects as coke ovens of various types, gas producers, metallurgical furnaces, &c.

General Notes.

SCHOOL OF ART WOOD-CARVING.—A course of four practical demonstrations in Wood-Carving will be given by Mr. W. H. Grimwood, at the School of Art Wood-Carving, on Tuesday afternoons, March 16th, 23, 30, April 6, at 3 p.m. In the first lesson the proportions of the human face will be dealt with, and afterwards practical demonstrations will be given on the carving of the entire face.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

MARCH 10.—"The Prevention of Fires due to the Leakage of Electricity." By FREDERICK BATHURST. W. H. PREECE, C.B., F.R.S., will preside.

MARCH 17.—"Music in England at the Queen's Accession." By J. SPENCER CURWEN. SIR WM. CLEAVER FRANCIS ROBINSON, G.C.M.G., will preside.

MARCH 24.—"The Transmission of Power by Alternating Electric Currents." By W. B. ESSON, M.Inst.C.E. ALEXANDER SIEMENS, Member of Council, will preside.

MARCH 31.—"Cycling—Historical and Practical." By GEORGE LACY HILLIER.

APRIL 7.—"Dairy Produce and Milk Supply." By M. J. DUNSTAN, M.A., F.R.S.E. The RIGHT HON. LORD BELPER will preside.

INDIAN SECTION.

MARCH 11, at 4.30 p.m.—"Prevention of Famine in India." By SIR CHARLES ALFRED ELLIOTT, K.C.S.I. (Secretary to the Famine Commission of 1878, and late Lieutenant-Governor of Bengal). The Rt. Hon. LORD GEORGE HAMILTON, M.P., Secretary of State for India, will preside.

MARCH 25, at 8 p.m.—"The Cultivation and Manufacture of Rhea Fibre." By THOMAS BARRACLOUGH. SIR WILLIAM HENRY HOULDSWORTH, Bart., M.P., will preside.

APRIL 1, at 4.30 p.m.—"A Visit to Russian Central Asia." By MICHAEL FRANCIS O'DWYER, I.C.S. (Assistant Commissioner in the Punjab).

MAY 6, at 4.30 p.m. — "Kafiristan: its Manners and Customs." By SIR GEORGE SCOTT ROBERTSON, K.C.S.I. (late British Agent at Chitral). FIELD-MARSHAL LORD ROBERTS, V.C., G.C.B., G.C.S.I., G.C.I.E., will preside.

MAY 20, at 4.30 p.m.—"India and its Commerce." By SIR JAMES LYLE MACKAY, K.C.I.E. (late President of the Bengal Chamber of Commerce).

The meetings of March 11, April 1, and May 6 and 20 will be held at the Society of Arts; and that of March 25 at the Imperial Institute.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

MARCH 16. — "The Progress of the British Colonies of Australasia during the Sixty Years of Her Majesty's Reign." By JAMES BONWICK. Sir FREDERICK YOUNG, K.C.M.G.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock:—

MARCH 30.—"Lead-work." By W. R. LETHABY.

APRIL 27.—"Delft Ware." By Dr. J. W. L. GLAISHER, F.R.S.

MAY 11.—"A Half Century of Line Engraving, 1780-1830." By GEORGE CLULOW.

CANTOR LECTURES.

Monday Evenings, at half-past 4 o'clock:—

PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., "Alloys." Four Lectures.

LECTURE I.—MARCH 15.—Alloys which are solutions of the constituent metals, and those which contain chemical compounds.

LECTURE II.—MARCH 22.—The diffusion of liquid and solid metals.

LECTURE III.—MARCH 29.—Steel and cast-iron, considered as carbon—Iron alloys.

LECTURE IV.—APRIL 5.—Advances in our knowledge of alloys since the last course of Cantor Lectures "on Alloys" was delivered, in 1893.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 8...Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Report on Mr. Macfarlane's Paper, "A New Life-saving Engineering Appliance." 2. Report by Committee on Lieutenant Abbott's Paper, "Ship's Davits in relation to Life-saving, with a proposed new form of Davit." 3. Mr. Henry O'Connor, "Carburated Water Gas."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Prof. A. Bostock Hill, "Factories, Workshops, and Offensive Trades."

Surveyors, 12, Great George-street, S.W., 8 p.m. Right Hon. Horace C. Plunkett, "Agricultural Co-operation."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Campbell Swinton, "Some Recent Investigations relating to X Ray Work."

TUESDAY, MARCH 9...United Service Institution, Whitehall, S.W., 3½ p.m. Dr. T. Miller Maguire, "The National Study of Military History."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. D. Waller, "Animal Electricity." (Lecture VIII.)

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on paper by Messrs. J. E. Worth and W. Santo Crimp, "The Main Drainage of London." 2. And on paper by Mr. W. J. Dibdin, "The Purification of the Thames." 3. Mr. H. A. Humphrey, "The Mond Gas-producer plant and its application."

Photographic, 12, Hanover-square, W., 8 p.m. Mr. W. L. Wylie, "Demonstrations on the making of Pictures."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Mr. Samuel Lowe, "The Dairy Industry in the Colonies."

Asiatic, 22, Albemarle-street, W., 4 p.m.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

WEDNESDAY, MARCH 10...SOCIETY OF ARTS, John-street, Adelphi, S.W., 8 p.m. Mr. Frederick Bathurst, "The Prevention of Fires due to the Leakage of Electricity."

Geological, Burlington-house, W., 8 p.m.

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. Baldwin Latham, "Indian Sanitation."

Japan Society, 20, Hanover-square, W., 8½ p.m. Mons. S. Bing, "The Series of Hokusai's Colour Prints, entitled 'The Thirty-Six Views of Fuji-yama.'"

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

THURSDAY, MARCH 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Sir Charles Alfred Elliott, "Prevention of Famine in India."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m., Prof. Percy Gardner, "Greek History and Extant Monuments." (Lecture II.)

Electrical Engineers, 25, Great George-street, S.W.. 8 p.m. Mr. H. Bencet, "Some Repairs to the South American Company's Cable off Cape Verde, 1893 and 1895."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Hon. Mr. Justice Wills, "Forty Years Mountaineering."

FRIDAY, MARCH 12...Royal Institution, Albemarle-street, W., 8 p m. Weekly Meeting. 9 p.m. Professor Arthur Smithells, "The Source of Light in Flames."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. H. F. Brand, "The Inverness Section of the Inverness and Aviemore Railway."

Astronomical, Burlington-house, 8 p.m.

Junior Engineering, Westminster Palace Hotel, S.W., 8 p.m. Mr. W. K. Beckton, "The Protection of Buildings from Fire."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. Mr. William Barlow, "A Mechanical Cause of Homogeneity of Structure and Symmetry Geometrically investigated, with special Application to Crystals and to Chemical Combination." (Illustrated by models.)

SATURDAY, MARCH 13...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, 3 p.m. Lord Rayleigh, "Electricity and Electrical Vibrations." (Lecture II.)

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FRIDAY, MARCH 12, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

The next course of Cantor Lectures on 'Alloys,'' by Professor W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., will be lelivered on Mondays, March 15, 22, 29, and April 5, at 4.30 p.m. instead of at 8 p.m.

HOWARD LECTURES.

Professor JAMES A. EWING, M.A., F.R.S., lelivered the sixth and last lecture of his ourse on "Mechanical Production of Cold," n Thursday evening, 4th inst.

The experiment of liquefying oxygen was erformed with a regenerative refrigerator upplied by Messrs. Lennox, Reynolds and 'yfe, and a number of the characteristic properties of liquid oxygen and liquid air were emonstrated by the aid of apparatus kindly ent by Professor Dewar.

At the conclusion of the lecture, Professor Ewing expressed his obligation to a number f gentlemen who had supplied information or ad contributed to the illustration of the ubject by lending diagrams or models. hanks were especially due in this connection Dr. Linde, Professor Schroeter, Mr. Windausen, Mr. Osenbrueck, Sir Frederick ramwell, Sir Alfred Seale Haslam, Mr. terne, Mr. Lightfoot, Mr. Hesketh, Mr. raham Harris, and Mr. H. F. Donaldson.

Mr. FRANCIS COBB (Chairman) proposed a ote of thanks to Professor Ewing for his aluable course of lectures, which was carried nanimously.

The lectures will be printed in the *Journal* uring the summer recess.

THE ALBERT MEDAL.

The Council will proceed to consider the ward of the Albert Medal for 1897 early in May next, and they, therefore, invite members of the Society to forward to the Secretary, on or before the 10th of April, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit for promoting Arts, Manufactures, or Commerce," and has been awarded as follows in previous years:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to His Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus Von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c.

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B,

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S.

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., late Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong (now Lord Armstrong), C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson (now Lord Kelvin), LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., late Professor of Chemistry in the University of Berlin.

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

In 1884, to Captain James Buchanan Eads.

In 1885, to Mr. (now Sir) Henry Doulton.

In 1886, to Samuel Cunliffe Lister (now Lord Masham).

In 1887, to HER MAJESTY THE QUEEN.

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S.

In 1889, to John Percy, LL.D., F.R.S.

In 1890, to William Henry Perkin, F.R.S.

In 1891, to Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S.

In 1892, to Thomas Alva Edison.

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.

In 1894, to Sir Joseph Lister, Bart., (now Lord Lister), P.F.R.S.
In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S.
In 1896, to Prof. David Edward Hughes, F.R.S.

A full list of the services for which the medals were awarded was given in the last number of the *Journal*.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, March 2, 1897; HUGH STANNUS, F.R.I.B.A., in the chair.

The paper read was or—

GESSO.

By MATTHEW WEBB.

Gesso work, so-called, one of the minor bye-ways of art, is a means of embellishment which touches on the one hand, painting, decoratively combined with a treated surface, and on the other, modelled relief decoratively combined with colour.

On the labels attached to many specimens of gesso work at the South Kensington Museum (chiefly on the west side of the Italian Court) the two terms gesso and stucco are used almost indiscriminately. The confusion, if it may be called so, is more than excusable, it is almost inevitable. The two terms have always been used rather loosely, and there is a certain interchangeableness not only between the substances but also between the processes. It is by no means always easy to tell whether a piece of work was executed in gesso or stucco, using the terms with a distinction which I shall hope to explain.

To give the derivative meaning of the two words gesso and stucco would perhaps help to make the distinction clear, but such Italian dictionaries as I have been able to consult do not elucidate the matter. They make both terms vaguely signify plaster. They do not say what were the meanings of the words before they were used by the artist, or how the use of the words came about.

In a saucer with water mix plaster of Paris, a sulphate of lime; in another mix thickly whitening, a carbonate of lime; and let both dry. The cake of whitening you can powder between the fingers, the plaster of Paris you cannot so crush.

This difference is owing to the fact that, in the case of the plaster of Paris, lime substance has first been subjected to great heat to drive off nearly all its moisture; in whitening, lime substance has not been calcined. The plaster of Paris is a type of stucco, but gesso more generally employs the uncalcined lime substance.

To put it another way; stucco is concerned with quick lime substance which by having been calcined will, uniting with water, re-form gypsum; gesso is concerned with lime substance or gypsum, which either has not been burnt, or has had its quick property destroyed, and will with water alone never really harden at all.

It is helpful therefore to use the words with this distinction of significance, contrasting them not as to method of manipulation but as to nature of subject.

Whereas a stucco, like plaster of Paris, will even set under water, gesso of whitening or chalk may be washed away by water. Consequently, gesso would not be used for exterior decoration.

Though the subject of this paper is Gesso, it has nevertheless seemed useful to touch on kindred stucco-work, especially since it is very difficult to speak of either historically apart from the other. The term gesso, however, will, whatever the manipulation, be employed, in this paper, only for that material which has *not* lime substance in it in any *active* form.

With regard to old work to be alluded to in this paper as gesso-manipulation, I do not venture to assert in every instance that it has been *not* stucco, but gesso. I only know from actual experiment that it could have been done in gesso; and, therefore, for all practical purposes, may be taken as example of gesso-work.

In the substances usually employed by the gesso-worker, all the binding, the hardening, the cohesion is given by the drying and hardening of glue and oil; in stucco on the contrary, these ingredients, so far from being necessary, can be injurious. Much that is executed in stucco can be equally well executed in gesso. It is usual, however, to execute heavier modelling and higher relief in stucco; for although in stucco has been executed very fine work, it is true the slightes fine raisings of surface are rendered most happily in gesso. It is roughly true that gesso is for the brush and stucco for the modelling tool yet gesso can be used very stiff and stucco very thin.

Much modelled relief of the past has every appearance of having been painted on from a full-charged brush, consequently you can imagine it would be very difficult to do that, except on a surface more or less horizontal, more generally then a panel. But a squeeze in gesso can be applied to a wall if the suction of the plaster of the wall be stopped. There is some evidence that this may have been done in the case of crowns and ornamental borders of paintings executed in Henry III.'s reign in the so-called Painted Chamber of the old Palace of Westminster. The beautiful works I refer to lasted half a millennium and then were deliberately destroyed.

Not only the methods of manipulation, but even the substances insensibly pass from one to the other. Plaster of Paris will mix with gesso that has oil in it, and yet will seem to retain some of its self-setting power, and a considerable portion of whitening may be mixed with plaster (1 in 3) without injuring its setting. He who works gesso in higher and more modelled relief will find himself ere long working also in stucco. For instance, the under work may sometimes be stucco and the top finish in gesso. Yet the gesso worker will be surprised to find how much more than brush-work he can do with gesso and still be using substantially gesso only.

BODY.

The glue, or oil, or both together, which have been spoken of, must have something to bind, which also will give them substance such as whitening, powdered chalk, or killed plaster of Paris. Other substances have at times been added such as pumice powder, and many others. At one time, so we are told, German artists used to mix finely ground honestone with their gesso.

GLUE, RESIN, OIL, &C.

Resin may be melted in the oil, and o resin, oil, and glue may be added a very small quantity of pitch melted in turpentine. The resin in the oil helps to give the gesso a hardness. The oil, and the pitch dissolved n turpentine, at least help to protect it from njury by moisture.

One use of the pitch is that it helps to keep he glue from going bad. If the glue goes sour he gesso, of course, will not harden, but gesso arefully prepared may be kept for months nd yet remain good.

Very little of the oil is required, less resin, nd still less pitch. It may be remarked that many leave out the resin, some leave out the oil, and very few use pitch.

The proportions for a pot of gesso are:—

10 ozs. of glue × $2\frac{1}{2}$ pints of water.
8 ozs. of resin × $1\frac{1}{2}$ pints of oil.
2 ozs. of pitch × $\frac{1}{4}$ gill of Venice turpentine.

Of these take 6 parts of the glue water, 1 of the resin oil, and $\frac{1}{16}$ part of the pitch.

A rough rule for the consistency of the glue-water is to make it so that it will only just set into jelly when cold. For the convenience of weighing the glue it may be remembered that Scotch glue has the property of becoming flexible without getting sticky, after soaking in cold water for twenty-four hours. In such condition it may easily be cut with scissors, and it is convenient to keep it in store in small weighed parcels and labelled. A store of jellied glue may be kept for some time by putting in a few drops of creosote or oil of cloves. When re-melting a little water must be added to allow for evaporation in heating.

White resin is the best, and if the student would be very particular he may use Venice turpentine in which to melt the pitch; but as a matter of fact the ordinary oily turps at the bottom of the tin brush-washer will do very well. Some put in Venice turpentine without pitch.

Then there are, to be melted separately, resin in oil, pitch in turpentine, and glue in water. Having thrown these together and heated them up again, into the mixture stir whitening either carefully rolled and crushed in the dry state, or previously well soaked. If soaked less water may be required in the solution of glue. The whitening sold as "gilders' whitening" is the best to buy and the student will be surprised to find how much whitening the mixture will take before the gesso loses its decidedly liquid character. Stir the mixture with the whitening in it well together; and always when possible keep it covered from the air till it is cold, otherwise the skin which would form is tiresome.

With whitening and glue is made a gesso for use with water-colour. At the consistency for the brush, gilders call this "thick white." A similar gesso was frequently used under gold by the illuminator in days when a page was not only for perusal, but for the pleasure of the eye. Gilders' stopping is whitening and glue at the consistency of dough.

The ordinary trade "compo" with which

frame makers make the ornament on frames is practically gesso, and may be softened for use by steaming. Putty used by glaziers contains oil and whitening; with the addition of glue this would be gesso.

In the resin varnish of commerce there is resin dissolved in oil, and at a pinch some of the various driers made for the house-painter's use would make gesso with glue and whitening added. Once get hold of the principle and there are many things which can be adapted.

By shaking them together, water and oil form a mechanical mixture, of a milky appearance, used by some as a vehicle in oil-painting. To this mixture add whitening, and a gesso is formed which hardens into putty as the water dries out of it.

Gesso will be required at different consistencies for different purposes. Naturally, if the proportion of whitening is increased so also is the stiffness of the gesso; it may be necessary then in order to make it bind to put more glue in proportion to water, and an extra proportion of oil to keep the whole from cracking as it hardens; this gesso would be used for heavier relief. In thin gesso, for very fine work, such as the patterns on borders of robes, the oil may be left out altogether, with the glue also weak. As a rule in working gesso the stronger glue is wanted in the earlier stages, the oil rather in the later; there the oil helps to give a finer surface finish if needed, and to protect the surface from moisture. With water and oil the final surface, if desirable, can be polished as fine as ivory, not that it is suggested there is any necessary advantage in smoothness.

SUCTION.

It is always unsafe to put gesso strong of glue over gesso weak of glue; and fresh gesso over old dried gesso, without stopping the suction first, courts disaster. The dried gesso has an absorbent surface, which is just what gesso does not well adhere to. The suction may be stopped by shellac, thinly or thickly dissolved in methylated spirits or naphtha, or by thin glue water, or both. The white polish of commerce is practically thin shellac; and patent knotting thinned with naphtha, occasionally answers the same purpose, which is to choke the pores of the gesso up with a hard gum, left behind after the spirit has evaporated. It is not possible to exaggerate the importance for the durability of the work, of this incessant stopping of suction The student may be impatient of the trouble, but safety is insured by stopping first with very thin shellac, and just before laying on the next gesso, damping the old with very thin glue-water. It is true that it will discolour the work, as will the oil in the gesso, but where the gesso is not depended on for colour, but will ultimately be finished with paint or gold, the discolouration will not be harmful.

GROUNDS AND CANVAS.

Having made the gesso composition, the student wants a ground to work on, and this must be non-absorbent. Gesso will adhere readily to wood, straw-board, *papier maché*, and similar foundations properly prepared with shellac, &c. To unprepared wood gesso adheres not too well, but firmly to glass and glass to it.

Whenever practicable, however, the best of all grounds is one itself of gesso laid into canvas, the meshes of which afford hold to the gesso, while a wood panel, if it be underneath the canvas, is to some extent secured against cracking.

The coffer-front, No. 318, in South Kensington Museum, shows canvas under the gesso.

In a description of process it is always interesting, if not positively instructive, to give instances from old work. Earlier paintings, in so far as they were "tempera," were in a sense in water as distinct from oil colour; they together with the later, though still early oil pictures, were mostly painted on panel. These panels were faced with a gesso priming, the gesso frequently laid in canvas over the panel. In the National Gallery, in Room II., may be seen work of the early part of the 14th century by Duccio di Buoninsegna, by Pietro Lorenzetti and others, which show this practice. In these pictures the panel is incorporated with the frame; and the ravages of time reveal, not only canvas underneath the gesso facing of the frame, but also underneath the gesso priming of the panel; a finely woven, but compared with the size of the panels, a stoutish canvas.

Vasari speaks of "ingesso" spread over picture panels as "sulphuric acid and lime." This should constitute stucco, but on the other hand it was also a method to take a set stucco material, crush it and grind it up afresh and use it dead, which would leave it truly gesso. The suction of the ground was always stopped by painting it over with size.

It may be something too much of a fashion to trace methods back to the valleys of the

Nile and Euphrates, but the 19th century, like the 16th, has it renaissance; and though in a revival one may make the paralysing mistake of seeking too much in the past for authority and precedent, it affords a respectable sense of establishment to be able to discover in the land of the Pharoahs Gesso traditions. In one form or another there gesso was used for the surface finish of mummy-cases. Where better shall the student look for the use of canvas with gesso, than to the Egyptians who used linen so much, and habitually manipulated soaked linen for embalming purposes. Speaking of gesso as a priming, it has from time immemorial been used to cover wood, carved or not, intended for colouring. See carved wooden statuettes in South Kensington Museum, and this practice may have suggested the priming of picture panels. The frame-maker to-day covers wood with what is practically gesso, before proceeding to gild it. It was also used to give surface finish before colouring to stone-carved effigies, such as those to be seen here in London, in the Temple Church, Westminster Abbey, &c.

PUNCHED PATTERN.

While on the subject of these grounds one treatment of gesso may be taken into consideration which, in early work especially, gave such interest and value to the effect. The dry gesso ground very well takes a kind of engraving which, when gilded, yields a delightful play of light. When the Florentines would paint a wing, the pattern on robe curtain or cushion, rays of light, or a repeated diaper on background, the knife, stylus, or punch came into use. The glory you may see radiating round the figure of the Christ in an Assumption of the Virgin, by Fra Angelico, is done by engraving ruled lines into the hard gesso ground, a method which was turned to many accounts. Where the gesso-priming of an old painting has fallen off, the bare oak panel may sometimes be seen indented by the impression of the punched dot, transmitted right through the gesso, thereby proving its hardness. The lines were of course engraved before the gilding and execution of the painting; and you often see, even in so careful a painter as Fra Angelico, that the painting has not been too nicely allowed for, and has had to encroach on the graven lines.

We need the glint of gold to get a full play and change of light and effect: radiating lines would be of little use in the glory unless the background were gilded afterwards. Over the gold very beautiful effects of colour have been obtained by glazing. (See "Adoration of the Magi," by Gentile da Fabriano, in the Academy, Florence.) Very fine lines, especially in illuminated manuscripts, could be pressed in after gilding; but it should be remembered that gold leaf in earlier times was used thicker and richer than the leaf ordinarily used to-day.

This treatment of the ground is not found much later than the middle of the 15th century, In that beautiful work in the National Gallery by Lippo di Dalmasio (Room V., Ferrarese and Bolognese School; a Madonna and child, with sun-glory, a moon, and angels), in effect broad and decorative, in design almost archaic, the painting is without any treatment of the gesso, ground by incision or otherwise.

For examples of this incising, attention might be called to the following works in the National Gallery:—The large Fra Angelico Annunciation—on the wing of the Angel Gabriel (Room II.); the background of the Cimabue (Room III.); rays round the figure of Christ in the long Fra Angelico Predella (Room II.); Madonna of French work—15th century—in the background, and in a halo which is placed high round the head, elaborately punched diaper (Room XIV.); Marriage of Virgin towards end of 14th century—Siennese School—Nicolo di Buonaccorso—frame and panel incorporate—frame brush—panel chase and punch, even under draperies. (Room II.)

There are many others, some of which there will be occasion to speak of later.

BRUSH-GESSO.

At the consistency of cream gesso will flow from the brush, constituting what is called "brush modelled gesso." A long thin brush is best for most purposes; never a quill, and for big work a hog. The "rigger" brush used by coach-painters is a good one. As the available brush is practically the drop of gesso hanging from below the hairs, you will see that long lines of slight or no curve are not easy to do without a break. Some of the processes by which china may be decorated with modelling, partially illustrates the manipulation of brush gesso. Some of the work is a little like painting on china with slip. The projections and gradations of form can be got by brush-stroke after brush-stroke, somewhat after the manner of *pâte sur pâte*. Another method is to lay with the brush, what I might call *cloisons* of gesso round a form; and then when the walls are dry and stopped, flood gesso into the interspace, rather after the manner of cloissonnè enamel.

Except as a diaper or in thin floral decoration, this brush-gesso work is of course hardly suitable for design intended to cover any large area; for large character of work, or for work which aspires to distinction or elaboration as modelling.

The work is beautifully shown on Italian marriage coffers, of which we have such fine specimens at South Kensington Museum. In them the gesso-worker was generally contented to leave decorative details, more or less high, soft and fat as they flow from the brush. Sometimes sharp edges to angular facets suggest a supervising scrape with a knife; and indeed for a similar purpose the worker may find it useful to keep by him different finenesses of sand and emery papers. Frequently when the outline was required to be sharp, the ground was punched with little dots. These not only gave difference of texture, but being brought up to the floral or other ornament sharpened the drawing. The dot *can* be made in gesso still soft, but a line cannot well be scratched or chased except into hard gesso.

In the case of the human figure, the face and features were generally left to be made out later by the paint-brush; the head being a mere general shape, vaguely and softly raised in gesso on the ground.

Many of the ornamental forms and conventions on archaic pottery are eminently adaptable to gesso work; and the very manipulation of the long thin brush, charged with fluid but thickish paint, after the manner of such decoration, is suggestive of brush-gesso. There is much brush-gesso in the work already alluded to, by Gentile da Fabriano, on the crowns, &c.

Before quitting this part of the subject attention may be called especially to the principle that brush-gesso is typically gesso-work. It thus constitutes an art which a painter can naturally take up; for it is in very low relief, largely depends on drawing rather than section, and is first and foremost brush-work.

USE OF FIBRE.

Both more quickly and more satisfactorily than by brush-gesso, heavier modelling and higher relief, to any desired projection, may be obtained by incorporating with the gesso various fibres.

These, such as tow, cotton-wool, horse-hair, wood-shavings, &c., may be pulled out or cut up and soaked in the creamy gesso. In a similar way even paper and rag may be manipulated and left stiffening in the hardening gesso to a required shape. Remembering that gesso and non-absorbent substances will adhere to each other, many things offer themselves to the worker's ingenuity, such as wire, and indeed any pieces of metal and glass. Card-board or straw-board and wood of course may come in useful, first painted over with shellac, knotting, or glue. String may also be mentioned as frequently of use.

For the use of string, probably wood, and glass with gesso, reference may be made to the raised work in the St. Peter of Crivelli's big altar piece in the National Gallery. (Room VIII., Early Venetian and Tuscan Schools.)

SQUEEZES.

There is another mode of using gesso, not perhaps so interesting to the artist as it is instructive. With or without fibre, gesso may be mixed stiff enough to take squeezes in.

I am not aware that any stucco can be manipulated so as to be really flexible, but gesso till it has hardened is slightly flexible. The hairy coat of the lion crest of the Black Prince's helmet at Canterbury exhibits the application of rhomboid shaped squeezes laid one against another round the body of the lion. Naturally in this stiffer gesso, to keep it from cracking as it hardens, stronger glue is required, with more oil, to bear out the increased bulk of whitening.

The following proportion would be a very strong gesso for squeezing in:—

6 lbs. of glue in 4 pints of water.
3 lbs. of resin in 3 pints of oil.
$\frac{1}{2}$ lb. of pitch in 1 gill of Venice turpentine.

Adding whitening till the consistency is that of stiff dough.

Taking for illustration earlier work rather than that of the modern frame-maker, mention may be made of a small frame in South Kensington Museum, decorated in Italian arabesques in very low relief. The run of ornament must have been squeezed in a mould and laid on while still soft to the wooden framework, and following the curve.

In a similar way small jewel caskets were frequently decorated with groups of tiny figures, each taken out of a mould and laid on separately while soft. You may often see where a figure is pushed up from behind by a part of another figure which it overlays. Frequently in a crowd of figures many of them are absolutely similar, showing that they are but adjustments of squeezes from one mould. Sometimes where bits of the figures have fallen off, the gold background on which they are laid, may be seen passing behind them.

There are a few fine specimens in the South Kensington Museum.

Though clearly put on soft they have not been so soft as to be flattened by the slight pressure necessary to fix them in place, a brush touch of soft gesso strong of glue probably being first laid on the ground to receive them. The particular kind of sharpness which these figures exhibit suggests the sharpness of the mould, nevertheless they may have been finished with the brush and knife. The outline of the figures is approximate only and squarish, the edges of them after lifting from the mould, having needed trimming with the knife. In the South Kensington Museum (No. 317) is a heavily clamped box profusely decorated with squeezes of equestrian figures from three or four moulds. They are beautiful, and very sharp, yet the paint-brush was resorted to, to some extent, for the making out of the features.

You can mould in plaster from thoroughly dry and well-oiled gesso, and a gesso squeeze will lift out of the plaster of Paris mould well oiled. The ornamental detail of most modern frames is practically "compo" squeezing, frequently from moulds carved in reverse in hard wood, the carving of which forms quite a trade in itself.

From the point of view of artistic principle, obviously in this squeezed work there is danger; the danger of the over-application of it where repetition does not sufficiently justify it; or of its misapplication, as to furniture and in other similar situations, where it seems to pass itself off as wood-carving. It has even been grained in paint. Pursuing this thought it may be surmised that even in the coffer decoration, under consideration above, though the work was certainly executed by hand and brush, a certain haste and wholesale execution, with oft-repeated design, carried into the workshop a mechanical element. If greed reduces a man to a machine, it will soon be felt that an iron machine, if not cheaper, will do the work more submissively, perhaps with more uniformity; and already, early in the 16th century gesso was being relegated to the squeeze. The preponderance of interest which during the last three centuries artists and patrons have taken in picture-painting has also had its effect. It has allowed the preservation of tradition of many of the arts, not Painting, to fall into the hands of the manufacturer, and not unnaturally he keeps them to himself. Consequently the student now, harking back to an old craft, has to work on somewhat in the dark; and it will be understood that proportions and recipes offered in this paper *are subject to constant revision by each experimenter*. The artist must be content to work on along more or less empirical and amateurish lines, but helping to re-establish tradition amid an open brotherhood, by adding experience to experience, and giving experience. This he will do; for the ways of Art cannot be the ways of Commerce; it is on his general capacity as an artist that he must rely for success and not on a craft-secret.

To resume consideration of what is of most concern to the gesso-worker, viz., hand-wrought work, it may be explained that squeeze-gesso has been dwelt upon at some length, only because of the fact that in the consistency for the squeeze the worker has a gesso which may be modelled with some facility by finger and modelling tool, keeping both oiled so as not to stick.

To pass rapidly to the conclusion of the practical part of the subject, it has been seen that gesso will take the graver and knife, for what is that chasing of the gesso ground but incipient carving. It is possible then to model in gesso and then carve it if desired, and so carry gesso-work to further developments.

Though perhaps, for heavier relief and by the skilful modeller, stucco would be preferred to gesso; yet gesso is far more under control, and recommends itself more naturally to the artist who has been in the habit of realising his conceptions in paint.

It may be pointed out, too, that a material like alabastine, which is a stucco, not a gesso, may, except with care, easily be used beyond the moment when it still retains its setting power, after which it will depend solely on the glue ground up in it for its hardening; whereas in gesso work it is accepted from the first that hardening shall depend entirely on glue and oil.

Speaking of stucco proper, there are two or three fine pieces of modelled stucco in South Kensington Museum, and in fairly high relief. No. 4 in the Italian Court, a Nativity, school of Donatello, and No. 1619, a Rape of the

Sabines, may specially be pointed out. Many Italian stucco reliefs are, I suspect, really casts. In the Italian Exhibition some years back, at the New Gallery, were two so-called gesso reliefs of "Madonna and Child," so adroitly differenced by painting that only on examining the modelling could you detect that clearly one of them, and more probably both, were casts, more likely in stucco, from a mould.

On marriage chests in the South Kensington Museum there is heavy modelling which looks like gesso. The cracks in it are the cracks which gesso would take, and the forms are still soft and fat, though the relief for gesso work is high; the surface before gilding smoothed probably with water and brush. At any rate, though roughly executed, there very likely is true work in gesso-duro and in distinctly high relief.

With then the conception he may now have of it, in gesso the painter will find a material with which he may carry work far beyond the limit of decoration: a material susceptible of impress from his own hand, more durable so far as it is less breakable than plaster; which hardening does not need the intervention of the moulder, and remains the artist's actual handiwork. Be this work called by some other name than "Gesso," or called bad names, modelling and carving tools do give ways of treating gesso, the substance itself so treated is gesso, and, to repeat, is connected easily with the painter's previous practice. In it he has sympathetic materials and methods with which to reach some subjects and treatment of subject, that by the closer realism of painting only, would be drawn out of a proper sphere of poetic abstract. For coloured relief is not an increase of realism, but the reverse: coloured sculpture in the round may be; but low relief is necessarily a convention, less realistic as modelling than the round; and yet, by the very departure from the flat, the relief makes it impossible for the painting to be realistic. It is really two removes from realism; by the convention of relief, and by the convention of colouring obliged by the relief.

The design should be suitable to expression in relief, and should also *need colour*. The work should be thought of as one art, where of the full attainment the modelling falls short without the finish of colour, the painting without the underlying modelling. Paint a piece of sculpture finished from the sculptor's point of view, and you spoil it; but in many an old painting on the flat, the work seems to suffer a confusion for want of modelling in relief; raise some parts of it, and it would be no less beautiful, no less removed and ideal, but all more rational and intelligible; conversely many a relief, without being exactly bad art of its kind, suffers confusion for want of colour.

Though gesso work may be left in the raw, and be beautiful so, it may be coloured in water, tempera, oil, wax, turpentine, or any of the vehicles ordinarily in use in a decorative painter's general practice, and in lacquers. Oil is likely to be the more durable, and goes better with the nature of gesso, and with oil-gilding. About gilding there might be much to say; of course it is not essential to gesso, but gesso is decorative or nothing, on which account gilding is valuable, as it always breaks realism, and forces you to be decorative.

But the artist will not stop at paint when he sees that he can fix into the gesso burning points of light by glass or precious stones as in many an old painting, and as may be noticed in that precious ruin belonging to Westminster Abbey, till lately just inside the gate leading to the south aisle of the choir, and temporarily removed; part most likely of altar furniture, a piece of work quite at the beginning of the 14th century. In this work is, I think, still left one precious stone together with two pearls or glass beads. There also may be seen let into little troughs full of gesso pieces of glass cut to shape. On the surface of the glass away from the eye and to be viewed *through* the glass, has been painted a pattern more or less geometrical; over the entire pattern has then been laid gold, and showing through interstices purposely left in the pattern; when dry the whole was laid gold downwards into the bed of adhesive soft gesso. There were also in this relic many miniature medallions of heads in profile, clearly squeezes from antiques. Whilst I am speaking of this treasure, I may mention that internal evidence points to its being English work. Of so early a date, probably contemporary with Giotto, there is but little painting out of England finer than may be found there in the picture panels. It looks as though England must have had a splendid eminence in art prior to the Wars of the Roses. The sad condition of this piece of work belonging to the Abbey, may be attributable in part to the fact that the gesso ground was laid directly on to the wood, except where the wooden frame-work and panels of wood have had the joints covered by strips of parchment.

I may perhaps now make some general remarks, though expressive, it may be, more of personal preferences than of principles.

Where gesso-modelling is associated with pictorial rather than decorative art, there should, I think, be either very much modelling or very little. Interesting as is the gesso workmanship in Crivelli's great altar piece in our National Gallery or the big "Adoration," by Gentile da Fabriano in the Academy at Florence; that it is there at all, suddenly rising out of the painting on the flat is in doubtful taste, compared with the rude but appropriate ornament on the coffer fronts which have been under consideration. In the latter though the scheme of colour, not counting the gilding or the faces of the figures, is very simple, confined to black and a transparent red, everything is expressed in the gesso. As a matter of fact, in conjunction with painting on the flat, and as that art progressed, the gesso-raising was early discontinued.

In like manner, for backgrounds, the impressed or graven diaper seems better than the raised diaper; and more consistent with recession, some slight suggestion of which the background must still give, even in the most decorative work.

Raised or impressed, the diaper is valuable for this reason: one of the most important elements in pictorial treatment is the sky with its aerial expression of distance; decorative treatment on the other hand is helped by the very exclusion of this element, and the diaper shuts it out and supplies its place in design.

It may be remarked that in the subjects of the various works considered in this paper for their display of gesso processes, there has been under contemplation, more often than not, the hierarchy of a mediæval Heaven; and further it may be objected that the imagination to-day no longer dwells on the old-world story of saint and seraph. But the purpose was to show not pictures, but craft processes, everyone of which is applicable to the decorative rendering of such impressions as may be derived from present day life around. It should be remembered too that, though perhaps their surroundings made with more singleness of heart for beauty than do ours to-day; to the artists who executed them, the coffer fronts we have admired, may very likely have been up-to-date designs of figures, the originals of which, vivid with life, were passing the shop-door as the brush was dipped in the gesso. To that past, the gesso-worker to-day must turn with even tender interest; and although art-history is not the business of the artist, it is a study not unprofitable, if from it may be drawn one moral, pathetic, yet assuring. Though, individually, workers soon pass away; though, opportunity and ability missing each other, not many become expert; few are successful, and most are soon forgotten; yet, by the sum of experiment one generation after another, the art to which the workers gave their lives, Herself lives, survives, and grows, monumental alike to the master and the *pictor ignotus*.

Gesso-work is necessarily rather small work, involving rather slow processes; the difficulty, therefore, of doing within the evening, anything in the way of demonstration which should be discernible and not teasing to the attention, has obliged me to confine myself somewhat to a mere talk about gesso-work.

There are, no doubt, many in the room who do gesso, and it has been impossible to avoid saying what many of you know. So much has been written on Gesso, from before the time of Cennino Cennini, among the Giotteschi, down to distinguished artists in our own day, that I have feared to weary your attention over the not generally interesting technical details of making and manipulation. If there should be any who care to ask questions relating to the practice, I shall be pleased to answer to the best of my ability.

On behalf of an increasing crowd of workers, as I think, fascinated by gesso-work, I hope I may have awakened or stimulated the patron's interest in the artistic value of what he might possess in hand-wrought gesso. Though, in the very pleading for art, I would add, let no one do too much possessing. Life must be simple to be, and to afford to be, beautiful. That is generically most art which is done by the personal living hand, and has afforded happiness in the doing; but if the artist must accept some privation, and this is true, to be an artist, so the patron must accept some sacrifice to enjoy the luxury of art. He who carelessly or assentingly enjoys art at the cost of the artist, may gain a world of art-treasures, but loses the soul to appreciate and enjoy them.

Addressing the student, always supposing him to approach gesso-work from the previous practice of painting, I would point out that he will see the obvious importance of studying modelling in clay or paste, and of studying the laws of low relief; this, too, without a mistaken conceit that he is really approaching the immeasurably more difficult, and for that very reason, humanly speaking, perhaps nobler, domain of the sculptor's art. Paint he should think of rather as a means of getting harmonious colour than as a means of getting verisimilitude.

He who would design for brush-gesso must do gesso; till he knows very well what he is about, it is nearly useless to design in any other material. The gesso-charged brush of itself ultimately determines and reveals that limitation of designing to which he must confine himself.

Accepting the nature of the material and not wresting it by wilfulness, let the artist bear in mind that in any art the truest art of it lies along the path of concession to the nature of the material to be worked in, he may then safely resist tyranny either of material or theories.

This just domination by material is not inaptly expressed by the following lines with which I will conclude my paper :—

With tactile hand; live symbol, human, of activity;
Sentient sure medium 'tween earth's clod and heaven;
Link but material to Intelligence;
Man's works shall grow, while his poised soul may see
That they are Art and his creations good.

DISCUSSION.

The **Chairman** said they might congratulate themselves that the interest of the subject had brought together so numerous and artistic a company, in spite of the very trying weather. They must all have felt, during Mr. Webb's long and exhaustive paper, how thoroughly autographic this material was; how it enabled the artist to do his own work, unlike the man who modelled for metal casting, or the architect, who designed a scheme of ornament and colour which others had to carry out. Here the artist might design as he went along (as in Pompeian decoration, or the charming Majolica plates at South Kensington) and hence there was a delightful sense of freedom in the work. Here there need be, there (properly) could be, no divorce between the designer and the worker; they were both co-existent in one individual—the *Artist.* Gesso had the further advantage, that it was woman's work as well as man's; there were no ladders to ascend, and no hard laborious hammering; but only such requirements as might be compassed by deft fingers and delicate manipulation. The quick observation, untiring patience, and free fancy, for which women were noted, were just the special qualities required in gesso work. Its appliability was very great; it would adhere to wood, leather, canvass, &c., and might be used for domestic work in combination with carving, lacquering, "compo-work," &c. Some of this last, by Messrs. Jackson, was shown. The founder of the firm of Jackson and Sons, Rathbone-place, was originally a builder in Bedford, but he left there to become a clerk-of-the-works to the Adam Brothers, about 130 years ago. That house and room and other buildings in the Adelphi neighbourhood were built by them, and probably the relief Frieze was Mr. Jackson's work. He was indebted to the great-grandsons, who now carried on the business, for the loan of one of the original intaglio blocks, into which the gesso now termed "compo" was squeezed, and also for a squeeze from this old time-worn and worm-eaten block prepared by their ancestor. It would be noticed that it was *sharp*, in contradistinction to the soft muscle-like texture of brush gesso; but that was a matter of arrangement, and when brush gesso was used in connection with squeezed gesso, either could be accommodated in treatment to the other, or the squeezed and sharper work might be used in the repeated parts of lesser importance, and the brush gesso reserved for the more important artistic parts in the storiation. He would conclude by moving a cordial vote of thanks to Mr. Webb, for the admirable manner in which he had brought the subject before them. He told him, whatever else he said, to be sure and give them full Recipes, because people always wanted to know "how it was done" as well as to see the effect; Mr. Webb had adopted this suggestion very fully, and he was sure they would all join in thanking him for his exceedingly valuable addition to their common stock of knowledge.

The vote of thanks having been carried unanimously,

Mr. **Webb**, in reply, said it had been a real pleasure to him to have the opportunity of talking about an art that he cared so much for. His thanks were due to South Kensington for the loan of some very precious things, and also to several gentlemen who had kindly lent him some of his own work. He was also much indebted to Mr. Stannus not only for taking the chair, but for the loan of the beautiful piece of Egyptian work he had shown.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 10, 1897; **William H. Preece**, C.B., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society :—

Harmer, Oscar, Hopedale, Spencer Park, Coventry.
Kirk, Percy, M.A., Seafield Technical College, Fareham, Hants.
Pither, Ernest Eugène, 36, Mortimer-street, W.
Scriven, Charles Herbert, Thong House, near Gravesend.
Smail, John Isdale, Black Mount, Chislehurst.

The following candidates were balloted for and duly elected members of the Society:—

Hine, George T., 35, Parliament-street, S.W.
Hunter, Surgeon-Major C.B., I.M.S., Chhindwara, Central Provinces, India.
Mansfield, Alfred, Messrs. P. Orr & Sons, Mount-road, Madras.
Verwey, Christinus, 17, Gracechurch-street, E.C.
Wilshire, Lewis W., 24, Strand-chambers, Derby.

The paper read was—

THE PREVENTION OF FIRES DUE TO LEAKAGE OF ELECTRICIY.

[Fothergill Prize Essay.]

By Frederick Bathurst, A.I.E.E.

Introduction.

It is scarcely sixteen years ago since the attention of the fire insurance offices was first directed to a class of hazards previously unknown to them, viz., the danger to property arising from the use of electric current for furnishing power and light. The currents which then came into use were proportionately, immensely larger than those previously used for telegraphic and other purposes, and now represent possibilities of energy which can be measured only in hundreds of horse-power.

Many will still remember the "danger scare," created about the year 1880 or 1881, upon the introduction of electric lighting by reason of the crude methods of wiring which were first adopted. Science and art, however, are in their nature necessarily progressive, and necessity has encouraged improvement and invention. In respect of electric wiring the increase in the demand for electric light has provided wider experience and demonstrated new wants. Public confidence has gradually become re-established, and it is now felt that the elements of great hazard are not necessarily inherent in all electric work, and that fires are preventable within the limits of ordinary wiring practice.

As this improved state of affairs must be ascribed, more or less, to the initial action taken by the various insurance companies—who ostensibly, for their own protection, posed as authorities, took the reins of guidance, and produced "Rules" for the purpose of ordering "safe wiring"—it may perhaps seem somewhat inconsistent to suggest that their rules may now even bar the way to further progress. Consideration of this paper may, however, show that in the light of increased experience and with the lapse of time, conditions are arising which prevent the rigid and consistent enforcement of the rules, and so failing to provide perfect safety and reliability, they are becoming antiquated and inoperative.

Although we are having fires caused by electric agency, of recent years we have escaped those of such a nature that public attention would be called to them, and confidence as to the relative safety of electric light has been secured. This acknowledgment becomes all the more desirable for us to retain when it has to be admitted that even with our restored reputation, there still lurks ominously in the public mind an undefined presentiment that electricity and electric fittings of all kinds are in some way "dangerous"—if only as presenting to the lay mind the possibility of an accidental shock.

It must, however, always remain a matter of congratulation that the early action on the part of our fire offices has so far enabled the electrical industry in England to escape the effect and criticism which would arise from the frequent occurrence of insidious and destructive fires caused through defective electrical installation work.

The problem of *safe wiring* is therefore of the utmost importance, and involves the main interest and welfare of the electrical industry. The writer will seek to prove that the greatest "safety" is to be found in adopting the best means of securing and maintaining "perfect insulation" so that it becomes necessary to enumerate the principles that we have to follow, and to ascertain the conditions under which they have to be applied.

Perhaps before proceeding in our review of the present methods of wiring it will be helpful to take a momentary retrospect of the development of an analogous service, viz., that of gas. When gas was first introduced, many crude methods of installation were adopted such as glass tubes, tinned iron, or copper pipes. These practices gave the needful experience which ultimately led up to the employment of iron pipes, the use of which, indeed, sprang from the utilisation of old worn-out gun barrels, until the increasing demand for gas stimulated the production of wrought iron pipes.

King's treatise on the "History of Gas Lighting" states that gas-piping service was at first very costly and cumbrous, and remained so until Whitehouse in the year 1825, took out patents for improvements in the manufacture of wrought iron pipe and produced it by machinery. It was the lower first cost of installation due to this improvement in production of gas-pipes, which afforded means for the general advancement of gas lighting, as it is on record that the chief impetus in gas consumption dates from the year 1830, that is the time when Mr. (afterwards Sir) James Russell took over Whitehouse's works and patents and largely increased the production of low cost iron gas piping.

CONDITIONS.

In order to compare the practice of "gas piping" with "electric wiring" we have to bear in mind the anomaly that electricity needs, instead of an orifice, a solid *material* as its conducting channel. The metal *copper*, owing to its good electrical conducting properties, has by universal consent become the favourite material to employ.

A length of copper wire affords a simple means of transferring electrical energy from point to point.

This energy, according to the transmuting or transmitting device employed, may be caused to show itself as light, power, heat or chemical action. A part of the energy thus transmitted disappears in the conducting wire itself, according to the opposition or "resistance" offered. This resistance varies directly as the length, inversely as the cross section of the conductor, and according to the specific conducting capacity of the material used, each conducting material possessing its particular specific resistance. Metals have, as a rule, the least resistance and are therefore usually selected as conductors. The portion of energy dissipated in the conductor because of its resistance really reappears in the form of heat, which action increases the temperature of the conductor above its surroundings, and unless the size or "sectional area" of the conducting medium is properly proportioned to the energy to be carried, this heating action may, from a fire-risk point of view, become serious—an over-taxed wire readily becoming hot enough to set fire to any inflammable material in contact with it. The conventional safe working current for copper wires has been fixed at 1,000 amperes per square inch of cross sectional area. The energy it is possible to pass through a wire is dependent upon the pressure or "voltage" at which the electrical supply is effected, and is measured by the product of the pressure or "voltage" multiplied by the ampere flow of current. The pressure or "voltage" which represents such an important factor in electrical supply may, by the non-technical, be taken as representing the power of the current to force its way along the conducting path by overcoming the resistance. The "voltage" also determines the ability of the energy transmitted to break through any environment or "insulation" which has been provided for the purpose of confining the current entirely to its conducting path.

As in the case of fluids where suitable pipes must be made and joints provided with a due consideration of the pressure they have to sustain, so also in electrical service—the metallic conductor has to be regarded in respect to these conditions, for, as "pressure" can burst a pipe, so "voltage" can puncture or pierce insulation.

Silk, cotton, rubber, and other insulating coverings have been placed upon wire for the purpose of confining the current to its proper path. These materials in comparison with a metal like copper, are such poor conducting mediums in themselves that they may be termed non-conductors or "insulators." The function of all insulators is to surround the conducting path with a non-conducting wall so as to prevent any extraneous deviation or "leakage" of current between the point of generation or supply and that of utilisation.

We see then that in the analogy between gas-pipe service and electric-wire service, it is the frail *insulating covering* of the electric wire which corresponds to the substantial *metallic coat* which forms the gas pipe.

Since in every electrical path or circuit we have a pressure or voltage constantly striving to break through the insulating covering, it is evident that the problem of safe and effective wiring is to secure and maintain *perfect insulation* for the conductors throughout their length and treatment. It becomes necessary therefore to study the nature and conditions of the insulating materials available.

Speaking generally of insulating materials it is found that the influence of "moisture" upon them is very deleterious; for moisture being itself a conductor, causes any insulating material absorbing it, to lose its insulating property. A current leaking through a moisture permeated insulating material produces heat, the material itself becomes charred, and entirely loses its insulating properties, all its specific virtue being ultimately destroyed.

As an insulating covering may be subjected to the influences of heat, arising from the conductor itself carrying excessive current, it is obvious that we should use an insulating material which is little affected by heat, although we find that our choice has to be modified by the consideration that heat-resisting materials are usually very great moisture absorbents.

In practice, moreover, insulated wires may be subjected to rough usage; it is important, therefore, to find materials which have sufficient inherent strength to withstand the physical vicissitudes.

In buildings, wiring is everywhere adjacent to wood or brick work, or in contact with plaster and cement. These building materials, when dry, may be classed as insulators; but if damp, they are, on the contrary, fair conductors, and able to act upon the insulating covering chemically, so as to eventually destroy its insulating properties. A current leakage into plaster or brickwork at some one point may not in itself cause serious damage, but the fact of its having "earthed" a portion of the circuit makes it hazardous for the same occurrence happening in another place. If leakage only presented a temporary interference to the working of an installation and the convenience of the user, it still should be avoided; but experience also shows that when backed by a dynamo and steam - engine, sufficient heat energy can be developed to cause a fire. Time, heat, cold, chemical action, and moisture are all powerful influences that may tend to deteriorate any of the insulating materials in use commercially; whilst, in addition, accidental damage of the material in the process of manufacture or installation must also be reckoned with.

Incipient electrical faults, such as above referred to, are not readily detected—usually only when a sensational notice of the defect is given. This possibility therefore further accentuates the necessity of insisting upon *good work* and the *right conditions* to start with.

An insulator to be perfect should be one that will keep its insulating properties under all conditions of temperature, being non-corrodible, durable, moisture-proof, fire-resisting, and a reliable armouring. This combination of qualities is at present only partially provided in commercial work, and considering the growing tendency to increase the voltage of supply, this "insulation" problem represents a strife between the power of penetrating and the power of resisting with an all too favourable possibility on the side of penetration.

EXPERIENCE.

The first electric wiring was done with wires very inadequately insulated and these were usually fastened directly against the nearest convenient support, with iron staples, brass saddles, or later with wooden cleats. If the insulation was not mechanically damaged nor the wires overloaded, and everything was kept quite dry, trouble would not perhaps be immediately experienced, but the natural moisture of the atmosphere or accidental conditions soon caused imperfections.

The leaking current could set fire to the partially insulating materials by gradually consuming minute particles, until the semi-conducting gases so generated would combine into a destructive "arc;" or if leakage occurs between wire and wire a "short circuit" would be created so as to cut the translating devices out of action, and allow the whole current to pass through the defective point.

The heating effect of the current increases directly as the square of its ampere value, so that the amount of heat generated by the short-circuit rush of current at the defective point can become very great, sufficient indeed to melt the conductor itself, and set the immediate surroundings on fire.

It is true that we seek to gain protection from such hazards by the use of "Safety Fuses"—thin strips of tin, or easily fusible lead-alloy wires—which melt and volatilise when an excessive current is passed through them, and so automatically form a break in circuit, and a means of disrupting the current. Such fuses are arranged in non-combustible containing chambers, usually earthenware, which will not be damaged by the momentary heat generated by the arc when the fuse melts. A "fuse" is designed to give protection against overloading a circuit; it has, however, its limitations. An abnormal current takes *time* to heat the fusible metal to melting point, thus introducing an element of uncertainty. Furthermore, a fuse does not give protection against a *leakage* of current less than that required to fuse it. In other words a fuse so small as five ampere capacity will not prevent a four ampere leak, whereas with favourable conditions a leakage current of two amperes can cause a fire.

Early wiring work was also defective in respect to design and workmanship, the electrical distribution being effected on what is known as the "tree" principle, in which a main wire feeds branch wires, and these again feed still smaller wires. Construction of this sort necessitates the use of a large number of fuse points and electrical joints, fuses being provided wherever it is necessary to make a junction of a small wire with a larger one. The joints presented many chances for imperfect work, and unless carefully made would give trouble. If two wires are joined together the electrical resistance of contact depends upon the perfection of the union, a slight or partial contact, say on account of rough or dirty surfaces, may mean high resistance, resulting in the production of excessive heat. The insulation of the joint is also an operation which requires care and experience, in order that the new insulating covering should be perfectly waterproof and mechanical, and correspond in effectiveness to the original protection. Carelessness in handling wires, besides damaging the insulating covering, may, in the case of a brittle conductor, result in partial fracture of the copper under the insulating coating. Under these conditions the wire may become heated, and an arc occur at the ruptured ends which can set fire to the insulation. Wires, again, which are too small for the current they are to carry, become over-heated, or the same result is attained if translating devices are changed or increased whilst the "fuse" has been purposely changed or strengthened to allow the increased current. Accidental contact of an imperfectly insulated wire carrying a relative high voltage, with another designed for low voltage, can result in damage to the latter. The improper placing of wires, or lamps, or the defects arising from poor and defective contact of binding posts and switch terminals, can all become fruitful sources of trouble, and swell the number of conditions by which electrically caused fires may result.

Most insurance companies preface their rules for electric wiring by reciting the principal sources of danger to be anticipated, including them under the following headings:—

1. Inferior material and workmanship, particularly in joints, fittings, and connections.
2. Conductors of inadequate size and conductivity.
3. Perishable and inferior insulating materials.
4. Dust, dirt and moisture.
5. Undue heating,
6. Neglect of frequent testing and inspection.

In the light of our previous examination of the possibilities by which electrical fires may ensue, we see that these conditions might be broadly summarised as troubles arising mainly under three headings:—

1. Imperfect insulation.
2. Imperfect conductivity.
3. Imperfect workmanship.

RESULTS.

The Insurance companies after their recitation of the danger conditions, add a paragraph by way of confirmation that no installation will be accepted by them as "a risk" in which all these conditions are not adequately provided against. It has already been stated that hitherto the experience of the English fire insurance offices has apparently been a singularly fortunate one, and although each office may hold records of the actual electrical fires which have come under its notice, no attempt (so far as the author is aware) has been made to classify in detail the causes which have produced them. Some inspectors may even urge that the fires have been too few to give real indication as to weak points in English wiring practice, but whatever the argument advanced, the utility of examining and considering the experience of some other country can hardly be questioned. The author holds therefore that the remarkably rapid and extensive development of the electrical industry in America, even though attended with a great number of electrically caused fires, may, if we are willing to make an unprejudiced examination, put us in possession of much practical and useful data which can well be studied with profit to ourselves.

In the United States the insurance authorities have been forced by their serious losses to establish a special bureau whose sole work is to examine and test electrical apparatus, collect and record particulars of electrical fires, and determine in detail their probable origin and cause. The results and deductions are very carefully arranged and tabulated in quasi-public reports.

An examination of the reports* of these

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* The author would here acknowledge his indebtedness to Mr. William H. Merrill, junior, the electrician to the Electrical Bureau making these reports to the National Board of Fire Underwriters, for copies of same and permission to make extracts.

electrically caused fires shows that a classification can be made under the headings we have already employed. We find that troubles from defective "insulation" or defective "conductivity" are included under the general term "conductors," whilst "inferior workmanship" includes constructive defects which occur in wiring material other than the conducting wires, as well as those arising from chance or accidental injuries. The records shows that defects in "conductors" cause nearly 70 per cent. of the total fires occurring, whilst "imperfect workmanship" accounts for the remaining 30 per cent.

If we arrange the headings in a tabular form, we find that the defects of conductors are ascribed to "crosses," "grounds" (earth leakage) and "short circuits."

In fairness to our comparison, however, we should note that fully one-third of the "conductor" troubles arise from "crosses" between the wires of different systems of electrical supply, such as telephone and telegraphic wires, with electric light or electric railway "trolley" wires, and between the two latter systems themselves. These fires have been caused by insulation breaking down before a very much higher voltage than that it was intended to withstand, and would not have occurred if greater precaution had been taken to prevent such possibilities. They occur in the United States on account of the method of overhead wiring, so largely followed for outside work upon the score of economy. They inculcate a lesson which may be taken as showing the wisdom, from a fire-risk point of view, of the English practice of putting all out-door electric light or railway wires, underground.

Analysing further, headings can be made showing that the "grounds" come chiefly from "structural iron work," "moisture," "metal pipes," "nails," and "over-loaded wires;" whilst "short circuits" result from "unprotected wires through floors," "flexible cords," "metal pipes," "fixtures" (chandeliers and electroliers) and "wood casing."

Upon analysing the cases of fire which occur from "poor workmanship" and "defective material" we see that "imperfect contacts" and "connections" alone give rise to as many fires as all those occurring in the translating devices themselves combined.

Tables I. and II. give in synthetic form, the analysis of the conditions causing electric fires. The sub-divisions may be taken as representing approximately, equal numbers of fires, the most prolific cause in each section being placed first, the others ranging in relative order:—

Table I.

Defective "CONDUCTORS" cause 70 per cent. of the Electrical Fires recorded, as the result of—

"Crosses" occurring with	"Grounds" caused through	"Short Circuits" arising from
Telegraph or telephone wires with electric light wires.	Structural or other metallic work.	Unprotected wires through floors.
Do. with "trolley" wires.	Moisture (electrolytic trouble).	Flexible cords.
Electric light wires with "trolley" wires.	Metal pipes (unprotected).	Metal pipes and fixtures.
	Nails.	Wood casing.
	Overloaded wires.	

Table II.

"IMPERFECT WORKMANSHIP" and Defective Materials cause 30 per cent. of the Electrical Fires, and are—

"Careless" or "accidental," recorded under	(or)	"Inherent" or "incipient," by reason of
Imperfect contacts and connections.		Transformers. Safety fuses. Switches. Arc lamps. Incandescent lamps. Motors. Lightning discharges.

Deductions.

These records, when examined, give us not only a statement of the actual hazardous arrangement which was the cause of trouble, but point out also how the destructive effects could best be counteracted. They indicate, firstly, that "leakage" should be prevented as much as possible, and secondly, that the formation of any arc consequent upon "leakage" or "short circuit" should, if possible, be localised in its effect. Further, it shows the necessity of somehow preserving intact the insulation of the wire, even though the troubles incidental to a conductor may arise. Although, theoretically, we endeavour to provide an insulating covering which may be considered sufficient to withstand ordinary usage, the occurrence of fire from such causes as "structural metal-work," "moisture," "metal pipes," "nails," &c., show the severity of the accidental conditions which may be encountered in practice. Wires are called upon to withstand damage from being dragged over rough floors, trodden upon by wiremen or labourers, and other untoward damage incidental to construction work. We know that the waterproofing and moisture-resisting qualities of the insulated wires in use, depend entirely upon the completeness of the covering, and also that the best material can be damaged by careless workmanship or unskilful manipulation; whilst it needs only the presence of moisture to set damaged insulating material on fire. We seek in practice to supplement this evident lack of essential mechanical qualities by providing that wires shall be installed in wood-casing or metal pipes. But before examining the relative merit of these practices, should we not ask ourselves whether there is any possibility of gaining greater certainty from the insulating covering itself, by making some other disposition of it which may be better suited to the conditions arising within or without it? Paradoxical as it may appear at first sight, insulating material, inflammable, if simply laid *upon* a wire, can in a large measure be made *self-protecting*, if applied *about* a wire. Perhaps I can best illustrate the principle I wish to impress by taking an ordinary piece of paper, which is in itself inflammable and easily ignited from the flame of a lighted match. If the paper is now wrapped around itself so as to form a tube, although it can be ignited by an outside application of the flame it cannot be ignited by inserting the lighted match inside it. Practically it is impossible to maintain a flame, within the limits of a tube scarcely larger in diameter than the burning material itself. *Such an inclosure acts as a snuffer, and its quality of suffocating combustion is in a great measure independent of the inflammability of the material of which the snuffer may be composed.* May not this principle be applied to the insulation of electric wires in order to meet the condition that the over-heating of an electric conductor can set fire to the insulation around it? Having noted this fact, we reach the point of this paper to demonstrate the advantages of a method of wiring, which is in reality a well-worked out scheme of *supplementing* (perhaps eventually even supplanting) the present method of attaching the insulation to the wire itself, *by providing a system of insulating tubes* into which the conducting wires can be drawn. Incidentally also, it may be shown that such a system of insulating tubes is not, as some have asserted, simply an additional charge on the first cost of an installation, but one which from its sufficiency, "reliability," and immunity from break-down brings more than sufficient economical compensation to merit any additional cost.

METHODS OF WIRING.

As before stated, the inherent lack mechanical strength in insulating coverin is recognised and some method of protectir them adopted. In England most of tl electric wiring work has been installed in woc casing. Owing to the fact that the great per-centage of the work already done has bee installed in old buildings which may be co sidered "dry," perhaps the slight property mechanical protcction that wood casing ca give to an insulated conductor, may, in th class of work, be considered as being fair well utilised. Wood casing, however, po sesses many defects; it can absorb and reta moisture, and retaining it will rot. If leakag occurs, the wood being inflammable will fir char and then take fire. Being combustib it also presents a medium for spreading a increasing a fire.* If desirous of proving tl unsuitability of wood casing, the experime should be performed of securing two co ductors of opposite polarity on a wet boar when if the insulation on the wires has be damaged, it will be found that "leakage readily takes place, and that so small current as two amperes is more than sufficie to set the wood on fire. Tests made the United States Electrical Bureau sh that wood casing can absorb moisture to t extent of 15 per cent. of its weight, and th every kind of treatment in the way of "pair ing" or "impregnating" with moistur repelling varnishes or fire-resisting co pounds, must be considered ineffective, bo from the electrical standpoint of "moistur proofing," and from the fire insurance stan point of "fireproofing." The report on tl matter expresses the opinion that wood *undesirable* for "supporting or encasi electric conductors," and concludes with tl significant remark that "it was to be hop that fewer feet would be installed in futu construction work." The main argumen advanced by advocates of wood casing are ready applicability and its possibilities f decorative effects. Whilst these may perha have some merit if the location is dry a mechanical disturbance is unlikely, it will no probably be generally allowed that, in view the uncertainty of maintaining the necessa conditions, wood-casing construction is ce tainly not applicable for new building wor and is certainly destined, in time, to be succeeded by more perfect methods.

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* A conspicuous instance of this imperfection occurred recently as October last at the Prince of Wales' Theat where a serious calamity was only averted by the effect action of those in charge.

Without wishing to make an evil prediction, the author would desire those insurance companies still upholding the use of wood casing, to be on their guard lest they shall find themselves nurturing this practice under the *ægis* of tradition.

The demand for perfection in mechanical armouring has led to the introduction of ordinary iron pipes, and a considerable amount of wiring work is now going on in which the two electric wires are simply drawn into an iron pipe. The writer contends, however, that this is only an intermediate stage in the development of electric wiring, and that time will again demonstrate that the pipe protection must not only provide mechanical, but *electrical*, qualities also. In the case of plain unprotected metal piping, we know that the effect of imperfect insulation on one conductor at a single point may be transmitted throughout the piping system, and await the occurrence of a second fault at any point upon the other conductor. When this occurs, unless the fuses happen to be small enough in size and act properly, it is quite possible that a hole can be "burnt out" of the pipe at one or even both of the defective points. Those who urge that "fusing" can give protection n the above condition surely ascribe greater perfection to this device than is consistent with absolute safety? Most of the fuses in practical use will easily carry from 100 to 200 per cent. more current than their standard rating. Generally also the placement of the fuse is eft to the judgment or experience of the constructing wireman and afterwards to whoever nay be in charge of the installation, and should t at any time become necessary to increase or enlarge the translating devices, there is no neans of counteracting the desire to replace a small fuse by one of greater carrying capacity. In any case, when it is shown that over-heating or leakage trouble can be obviated in a *nore perfect manner*, I maintain that it is not he best practice to depend upon fuses as 'safety" devices. Such fuse construction is certainly hazardous and seriously menaces perfect and uninterrupted service.

Again, those who state that they are willing o depend entirely upon the perfection of the nsulating covering surrounding the conductors annot surely have had practical experience with ordinary iron pipe construction? Anyone who has cut an iron pipe in two will allow that . "burr" is formed on the inside edges of the severed ends which is sharp enough to abrade or tear any insulating covering. This means that every piece of plain iron pipe cut up on an electric wiring job, must, if safety is to be ensured, be carefully and effectively reamed out. It is *not* satisfactory to feel dependent for good service and safety upon this condition, for can we hope that every wireman will give exact and careful attention to this point? Or feel at ease in the hands of new or careless men? On the other hand, if an insulating lining *is placed inside an iron pipe* it inherently provides against the most wilful carelessness that can be suggested or the worst "burr" that can be made.

With an insulating lining all doubt is removed as to the interior smoothness of the tube and, providing the proper thickness of lining is chosen, no burr can be caused to cut through it into the inside of the tube. The possibility of moisture and electrolytic trouble is prevented and not only is the insulating material on the conductors placed under favourable preservative conditions, but the further safeguard is provided of an imperishable insulating protector permanently ensconced behind an effective iron armouring.

Furthermore, experience has demonstrated the necessity of insulating electric fixtures from the gas-piping of the building, because if this is not done, a defect occurring on the electric fixture would be transmitted throughout the gas service. The insurance rules state that it is "entirely inadvisable" to combine electric light fittings with gas-fittings, and allow such practice only under the protection of an insulating joint. Surely those who would advocate plain iron pipe for electric wiring, entirely overlook these determinations?

Many instances can already be quoted where the union of gas with electric fittings has resulted in disaster to both, either lighting agency having the ability to release the other. The author believes that practical experience will show that where gas or water systems are used concurrently in the same building with electric wires, unless an auxiliary insulation *is* provided between the insulated conductor and the metal piping system, unlooked for troubles will occur.

The main argument that can be advanced by plain iron pipe advocates—that of lower first cost—does not hold, if regard is given to uninterrupted service and to the future.

At the present time there are advocates to be found for "earthed" wiring systems, one method suggested being the use of a single insulated wire within an ordinary iron pipe. The pipe is to form the return conductor, and is to be guarded against as such. Under the conditions which pertain to such a system the advantages arising from an insulating lining inside the pipe are apparent, because any overheating of the conductor would be effectually guarded against, and there would not be the possibility of a "short circuit" burning out the iron pipe. It is also suggestive to notice that on such a metal-pipe-return concentric system an insulating joint at the fixture outlets would be entirely out of place, since its insertion would break the metallic continuity of the return circuit. Combination gas fittings connected with it would, therefore, present a fire hazard. On the other hand, a *bare copper wire* insulating-lining-metal-pipe concentric system would have the advantage in these respects. Although an "earthed" wiring system can be advocated on the score of low first cost, the writer believes that the difficulties it introduces (if not insurmountable in extended practice) should only be approached with diffidence, and, therefore, prefers (for the present) to advocate a system in which both lead and return conductors are insulated and enclosed under the covering of an armoured insulating tube.

REASONS FOR ADVOCATING INSULATING TUBING.

The wiring system thus advocated as best and safest, would be a series of continuous tubes or conduits of insulating material which can be placed throughout a building after the manner of gas or water pipes, the conducting wires being afterwards drawn into the tubes. In this way the conductors are insulated electrically from all the materials used in the building, whether plaster, wood or stone work, gas or water pipes, &c., and the wood-work of the building is effectually protected from being ignited by "leakage," or the "accidental heating" or "short circuiting" of the wires themselves. The effects of "careless handling" or "defective workmanship" are also readily detected and remedied. For these reasons, the building is effectually protected from the liability of fire arising through electrical service. Insulating tubes can be found which are waterproof, and will provide a high and durable insulation unattainable by any other method or at as low cost. Such a system can be installed coincident with building construction, and lends itself effectively to the placement, alteration, repair or enlargement of the conductors. A suitable metallic armouring provides protection from external trouble whilst all internal trouble arising from moisture or damaged insulating material o the conductors, are, from a fire-risk point o view, absolutely counteracted. From a practical point of view, every desiderata i provided. Any defect in the tube constructio itself would prevent the wires from being drawn in, so that the raceways themselves have to b mechanically perfect. The wires need no be brought into the building until all construction work is done, and are, therefore, no so liable to accidental damage, so tha increased surety of insulation on the wir itself is obtained.

A perfect insulating tube should not b liable to decomposition by heat; should withstand moisture and resist electrolysis, be cheap durable, pliable, strong, and not liable to shrin or warp. Such tubes can be produced, an are already commercially successful.

Many independent tests have been made b well known consulting engineers and others in respect to the realisation of the abov advantages. In order to reproduce the condition where the insulation between two wire in the same tube might break down, "arcs" have been formed in a tube, with the result tha the arc was found to last only a few seconds and affect the tube but slightly. To reproduce the condition where a conductor become heated through an excessive current, a insulated wire was placed in a tube and a increasing current passed through it until th conductor was burned out. The tube becam heated, but was not set on fire. To reproduc the worst possible moisture conditions a armoured tube was used, slightly bent an filled with water. After 24 hours' soakin an insulation resistance measurement wa obtained of eleven megohms, which wa maintained as a permanent value throughout the series of tests, which were continue for several days. To prove the feature o "accessibility," a wire was placed in a tub both were kept at a temperature of 190° Fah for 50 hours and then allowed to cool. was then shown that there was no sticking, an the wire could be withdrawn with ease.

Turning once more to the United States fi records, *one single fire* will be found recorde as having occurred upon wiring carried out i insulating tubes, whilst it is a fact that the are already many more lights installed in th manner *than for the total lighting* *England*. The report of this fire, in deta hows that an " unarmoured " tube had been nstalled, and that this had been broken etween floor and ceiling—probably through areless construction work—moisture was thus ble to affect the insulation on the wires at the nprotected point, and a " short circuit " esulted.

In order to determine the merit of iron pipe *ith* an insulating lining over plain iron pipe, he following tests have been made :—A length f bare iron pipe and another of insulating ubing were taken, and two insulated wires un through both, under exactly the same conlitions. These wires were short circuited, vith the result that a hole was blown in the ron pipe, whilst the insulated iron pipe stood he test perfectly. A 150-ampere fuse was rranged in the circuit employed for this xperiment.

Again, an ordinary insulated wire was taken nd the insulation on it damaged—the wire vas then run through both tubes—and in rder to reproduce the conditions of moisture ccurring, cotton waste impregnated with a austic soda solution was applied to the lamaged insulation inside the tube in both ases; the tubes resting on damp woodwork, ide by side, about 4 inches apart. Between he tubes an iron bar was placed forming he earthed pole of a supply system. This rrangement was intended to reproduce the tate of affairs that might obtain when the ipes were fastened to a floor board or wooden eam attached to the iron girders of a uilding.

Current was applied, and under the above onditions the " leakage " arising from the lefective wire placed in the bare iron pipe, aused a fire to break out on the woodwork vhilst the insulated iron tube stood the test vithout suffering or causing any damage. It vas further found that a fire could be caused vith such a small " leakage current " as 1½ mperes, a three-light fuse placed in the ircuit remaining intact.

CONCLUSION.

Perfect electric wiring should combine in the ullest degree the attributes of safety, accessiility, convenience, economy and durability. The author has endeavoured to point out that n insulating tube method of wiring does proide " safety " by giving the greatest surety of ction and freedom from the danger of fire. n respect to " accessibility," it provides for xamination, replacement or repair to any part f the circuit with a minimum of trouble and expense. With respect to " convenience," the insulating tube is first fixed, due regard being given to the requirements of the building, and then completely fulfils its function of protecting the conductors. In regard to " economy," material utilised in the highest degree must admittedly be economical. Finally, as to " durability," a tube can be constructed, the materials of which are in themselves practically imperishable, and which at the same time find preservation for the conductors.

In short, it is thought that an insulating tube system fully meets the various conditions of safe and perfect wiring, compensating crass ignorance, and counteracting gross carelessness on the part of those installing or using the electrical service.

The true priniciple which should guide the insurance interests is really the *absolute prevention* of fire, inasmuch as any fire loss at all, necessitàtes that the community at large suffers—the rates charged being regulated from the total actual loss of the combined companies. The continued extension in the employment of electricity for power, light and heat, must, if properly directed, tend to minimise the occurrence of any fires, and it is hoped that a case has been made out to show, that an insulating tube or conduit system of wiring, provides the best means of preventing fires arising from the leakage of current to earth, and the other causes of danger in electrical installation.

DISCUSSION.

The CHAIRMAN, in inviting discussion, mentioned that this paper had won the Fothergill prize of £25 for the best essay on the subject of which it treated.

Mr. H. GRAHAM HARRIS said the author seemed rather to condemn the insurance companies for having first promulgated and then insisted on certain rules and regulations to which those engaged in wiring work rather objected ; but it seemed to him that at any rate they had been justified by their success in preventing fires. On the Continent, however, where there were no such rules, and where the work was done in the roughest possible way, the wires being secured to metal cleats, and sometimes practically almost touching each other, he did not know that the number of fires had been excessive. The Insurance companies, however, accepted wooden casing, and there were miles of it in existence. In one of the earliest installations he had to deal with he was seriously impressed with the risk of fire, and he then had a sample shown him of twin wires, or a single wire surrounded by insulation, and that again covered by a lead tube, wrought on cold, and thinking it a useful thing he used it. It would have been very successful indeed if it had not been for the British workman, who proved absolutely incapable of making a decent joint on the pipe; he made the joints on the copper wire and on the insulating material fairly well, but there were always difficulties in joining the lead pipe, and within a year or two the whole of the wiring had to come out and be replaced by an ordinary insulated cable, placed in a wood casing, and that remained to the present day without giving any trouble. Very possibly the plan advocated by Mr. Bathurst would answer very well in a new building, if carried out with care, but it occurred to him there might be difficulties in making the joints and elbows, and particularly in the outlets where the connections were made to the fittings. Unless the greatest possible care were taken there, all other precautions would be useless, and the installation would not practically be equal to the ordinary wood casing.

Mr. ARTHUR WRIGHT thought the title of the paper would have been more appropriate if it had been called on "Increased durability of electric light wiring." He had had some years experience, and in his opinion the danger of fire from electric lighting wires was practically insignificant. He had used ordinary twin wires, stapled up to the ceiling with 2,000 volts pressure between them and the earth, and had never had a fire. At the same time he agreed that the wood casing system was not so durable as the Interior Conduit system which had been described. It would do a great industry much harm if exaggerated ideas about the danger of fire got abroad, and after all the real question was how to make the outside protection of wire permanent. The wood casing was not by any means water-proof, and often concealed a multitude of bad joints, and much bad workmanship. The insulated conduit system would minimise that sort of thing, but the main point of interest to him was the question of price. It was no use reducing the price of electricity per unit, if the cost of wiring were kept up to £1 per light. So long as that remained, the ordinary householder would not have it.

Captain FOX (London Salvage Corps) said he could not speak as an electrician, his aid being called in after a fire, not before. There had been some very serious fires caused by electricity, probably by bad wiring. At the Prince of Wales' Theatre, the mischief arose in the switch board, which was made of the wrong material, and not properly insulated. The most serious electric fire in London, was in 1895, at the electric light station in Sardinia-street, when two floors were entirely burned out. The insurance companies could not but be flattered by Mr. Harris's endorsement of their views, and he thought he was also right in saying that many sins lay at the door of the British workman. The wooden casings were undoubtedly dangerous when they once caught fire.

Mr. I. BRABY asked what special advantages M Bathurst claimed for his system as compared with close-fitting lead tube ; the only one he could imagi would be that you could draw in more wires if r quired, but in most houses it was generally know what number of lights would be required when t pipes were first laid, and further wires would seldo be wanted.

Mr. FLETCHER asked if asbestos had been tried a covering for wires, and if it were damp-proof well as fire-proof.

Mr. J. HAWBRIDGE said the United Asbestos Con pany, which he represented, some years ago introduce a form of asbestos for protecting these wires, but was not much used on account of the expense. Th made it into tubes halved longitudinally so that th could easily be placed over wires. It could be ma quite damp-proof.

Mr. WILLIAM HEAD suggested that the thi heading, defective workmanship, would cover bo imperfect insulation and imperfect conductivity. T greatest safeguard of all was to use nothing but t highest class of cable and of sufficient section, b that meant a high cost. A great deal of the evil aro from allowing people to undertake work which th did not understand. He did not see any particul advantage in a system of iron pipes coated wi bitumen and papier maché, as compared with open iron pipe, and this had been adopted by son of the leading insurance companies. If the section area was sufficiently large there was no difficulty fro the burring of the pipes where they were cut ; b if the men found any undue resistance in drawi the wires in, they would at once stop and see whe the difficulty was. This system allowed of parti short circuiting to dead earth, and the result was rush of current passing down to earth through t iron pipe which disconnected the circuit at once, if were properly fused. He did not think the experime which had been shown with the match and the r of paper was quite analogous. The light was mai tained by absorbing oxygen from the air, and wh the air supply was cut off the light went out, but t electric light would burn in a vacuum, and imagined that if a wooden pipe lined with pap were used, a leakage would burn it out. Vulcanis joints were used with the plain iron-pipe system, whi gave better insulation than the indiarubber on t cable, and obviated the possibility of any leakag There was also the advantage of junction boxes various intervals, which gave facilities for examin tion. Switch boards were sometimes made of sla or marble ; they should be of ebonite or some su material. The great trouble was the craze for chea ness, so that you could not get good work paid properly. Wood casings did very well if they we perfectly dry, but when any damp got to them the was danger.

Mr. W. R. **Commings** explained, at the Chairman's quest, that the inner coating of the tubes described the paper was formed of a special paper, prepared ith an insulating material, and rendered fire and ater proof. The paper lining was made smaller than e metallic tube, and after being placed inside it, as expanded to it by pneumatic pressure. It was ade in 10 feet lengths, and elbows and bends were so supplied for making joints. The lengths were ined by insulating couplings.

Mr. F. C. **Raphael** thought one of the most ngerous parts of an electric light-system was the xible cord. At 200 volts, an eight candle light ly required one-sixth ampere, and a fuse could not put in which would blow at one-third ampere; e smallest size fitted up was one ampere, and the maining five-sixths, if it were leaking for some ne, might easily cause a fire. In most flexible cord tings, the switch was at the wrong end of the cord, e lamp end, and a person who did not understand would think that, by turning off the switch, it was l right, though the wires in the flexible cord still d the current in them, unless the block were moved. He did not see how Mr. Bathurst's system ould remedy this defect. He should like to know the armour, or metallic tube, was in electric contact roughout or insulated at the joints.

Mr. **Arthur Holland** said he understood that e tubes described were flexible, but the specimens own were not so. He should like to know the st of these tubes as compared with ordinary cables d wood casing.

Mr. **Bathurst**, in reply, said there would be no ssibility of moisture getting in at the joints in the bes. The idea was to get a system which should in every way analogous to a gas-pipe, and he saw reason why as good a joint should not be made as a gas-pipe, which should be both waterproof and essure-proof. Instead of using white lead and oil, a gasfitter did, they used white lead and shellac rnish, which made a perfectly hard cement, and set hard as a rock in half an hour. The outlets were ovided for by bringing the terminals into an insu- ed iron box, where the connections were made to e fittings, thus obviating any danger from friction. side these boxes were placed porcelain fittings by eans of which any sort of connection could be ade. The title of the paper was given him, and he d to work to it, or he might have chosen another e. Though there had been comparatively few es in England, there was such an increase in the e of electricity that, unless precautions were taken, eat danger might arise, and his object was to event it. The American insurance companies d had to take up the question in self-defence, but ough there had been 1,600 fires there from this use, that was only 2 per cent. of the fires from all uses. The question about the cost was probably e most important of all, for if the cost of electric wiring could be reduced, the consumption of electricity would be largely increased, and they hoped to be able to accomplish this in time, even with armoured conduits. The fire at the Prince of Wales' Theatre, no doubt originated at the back of the switch board, but there it got hold of the wood-casing, and ran up it to the flies immediately overhead. When Mr. Braby read the paper, he would see many arguments tending to show the superiority of his system to that of a simple iron pipe. Asbestos was one of the first materials experimented with, but though magnificent from a fire-resisting point of view, it was one of the worst for resisting moisture, and they never succeeded in finding anything which would render it water-proof. If Mr. Hawkridge had discovered such a material, he had a good prospect before him. Mechanical strength was also a desideratum, and there again, asbestos was deficient. No doubt, imperfect workmanship might be held to cover all the defects he had referred to, but he used the term rather to represent accidental defects, which did not make their appearance at once, and also structural defects, in apparatus and fittings, such as could only be remedied by further knowledge and experience. Mr. Head represented a firm which did a lot of wiring to iron pipes, and naturally he believed in them; he admitted that his system would cost more, but it had several obvious advantages. His grievance against the insurance companies was, that having been so successful up to the present with their regulations, they refused to look at anything new. If the insurance companies would allow of their using the insulating pipes without the metallic armour, which would be every bit as safe as wood casing, and safer, they could reduce the cost of wiring considerably.

The **Chairman** said he could not help calling in question to some extent the statement that moisture was so deleterious to the insulation of wires. In the branch of the public service with which he was connected, they were only anxious that the cables which ran all over the world should remain in peace and comfort at the bottom of the sea. If one thing more than another conduced to the durability of gutta-percha and indiarubber, it was its being kept constantly at one uniform temperature under water. The great evil was not moisture, but alternations of moisture and dryness, and heat and cold. Such changes caused the elasticity and viscosity of the insulating materials to disappear; then it cracked and the moisture got in, and they got electrolysis and leakage. To guard against these evils, fuses were introduced, and though he should be sorry to say one word against their proper use, he could not speak too strongly against their abuse. His experience was that out of one hundred faults in an electric light installation, ninety-nine were due to the fuses. By the rules of the insurance companies they were forced to introduce these fuses wherever they could be put. Fortunately, he was in a position where they were not subject to these rules. The Government offices were their own insurers, and made their own rules, and they reduced the number of fuses to the smallest possible limit. It was to a certain extent a satisfaction to an English engineer, that for statistics about fires caused by electricity he had to go to America, where very interesting and valuable reports were written upon them. That was because they had so many fires, but this arose rather from climatic conditions than from difference in practice. Here there was abundance of moisture; in America it was just the reverse, for there all wood work was in such an inflammable condition that the least spark would set it off. But there was one thing in which our practice in England differed; that was the care bestowed, first in specifying what was wanted: secondly, in having the work done thoroughly, and properly inspected; and thirdly, in being guided by the regulations of the insurance offices as well as by those of the Institution of Electrical Engineers. So long as this was done there need be little fear of danger from fire. He did not like to hear the British workman abused, for his experience was that when properly educated and looked after, and properly instructed in the work he had to do, he did it as well as anybody on the face of the earth. Great pains was now being taken to establish technical colleges and evening classes, and the British workman was seizing with avidity the opportunities given him to improve his knowledge, so that he might gain that power of assisting his hands with his brains which was the proper outcome of technical education. It had been a most interesting discussion, though he was sorry there had been no one to speak up for wooden casings, or for the concentric system. The latter system not only provided safeguards against fire, but also against personal injury which in these days of high voltage was of great importance. He concluded by proposing a hearty vote of thanks to Mr. Bathurst, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

THE INDUSTRIES OF GHENT.

Although constantly developing, the city of Ghent is far from keeping pace with other European cities in the increase of population which characterises the second half of the nineteenth century. Forty years ago Ghent was the second city of Belgium; now it is only fourth, Antwerp and Liege having successively passed it. Ghent lacks the attraction which induces country people to leave their farms and settle in a city; a rapid industrial development is wanting. No new large industrial establishments are being founded; the old, indeed, continue to develop more and more, and are making Ghent a large manufacturing city; but, according to the American Consul there, powerful initiative is paralysed. If the three great branches of Ghent industry—flax spinning, cotton industry, and metallurgy—are considered, it is found that o the twenty principal establishments, not one has bee founded during the last twenty years. Two wer founded during the last century, and employ 97 hands; five between 1815 and 1830, employing 2,87 hands; four betweeen 1830 and 1840, employin 5,313 hands; three between 1850 and 1860, employing 2,729 hands; three in 1864, employing 2,23 hands; one was founded in 1873, and employs 68 hands, and two were founded at a date not indicated but prior to 1875, and employ 775 hands. All thes twenty establishments, it will be observed, wer founded before 1877 and employ a total of 15,54 hands. The 3,259 other establishments employ onl 19,862 persons. In the other branches of industr not one can compete with the twenty establishment named. During late years, however, the weavin industry has constantly developed. Ghent, therefore is a city whose industrial development is in the past and forms an excellent comparison with Mannheim a city of recent industrial growth. If the number o new establishments is limited, the old ones, nevertheless, continue to rapidly develop, so that the industrial population of Ghent is one of the densest. I total population Ghent is the fourth city of Belgium but for the number of working people engaged i manufactures, it is first. The textile industrie employ nearly one half of the working population o Ghent (16,082 out of 35,317), followed by the clothin industry (5,837). Owing to the great developmen of the textile industry female labour is very extensivel employed. For every 1,000 men employed at Ghen there are 618 women; at Brussels, 586; Liege, 261 and Antwerp, 233. In all Belgium the proportio is 323 women to 1,000 men.

Correspondence.

ENGLISH ORCHARDS.

The paper by Mr. George Gordon on Englis orchards and the general cultivation of fruit tree is most useful and interesting. I have for some yea past prided myself on apple growing, mostly tabl fruit, such as Blenheim Orange, Cox's Orang Pippin; of the cooking varieties, Lane's Princ Albert and the Newton Wonder. To be successful, I have found that great care and attentio is necessary in the gathering of the fruit, and i pruning the trees. If this is carefully attended t the orchard will produce good fruit every year; i the careless gathering of apples, most of the frui forming buds for the next year are destroyed; th same with pruning, nearly all ordinary gardeners us the knife so very freely, cutting off fruit-bearin branches, that it generally takes a year for the tre to recover itself and bear fruit again.

Year after year I have apples, and can keep the ound and in good condition within a month or two f the trees bearing again. I have fruit now sound nd in splendid condition; but not a great quantity, ur consumption being large.

The great thing is to carefully hand-pick the fruit n dry weather, laying aside all that are bruised. If his is done, and care taken in storing, you will have uit for your table at this time of the year that no oreign fruit can equal.

BENJ. KITT.

Sydney-lodge, Bathwick, Bath.
8th March, 1897.

General Notes.

RENNES EXHIBITION.—Information has been eceived from the Foreign-office through the Science nd Art Department, that an Industrial and Comnercial and Art Exhibition will be opened at Rennes n May 2nd next. Particulars of the Exhibition can e obtained from Mons. L. Petit, Advocate at ennes, France.

MEXICAN AND CUBAN CIGARS.—The United tates Vice-Consul-General at Mexico, in the course f a recent report on the great increase in the cultiation and export of tobacco from Mexico, mentions hat the Mexican leaf is now taking the place ormerly held by that of Cuba in the manufacture of Iavana cigars. At first Mexican cigars were exorted, but they failed to give satisfaction, because it as found that boxes marked "Colorado," Colorado claro," and even "claro," when opened ontained "maduros," and even "oscuros." In time was discovered that this was not due to either aud or mistake, but to the remarkable ripening of he tobacco between Vera Cruz and New York, so hat "claros" became "oscuros." Hence the leaf as exported in place of the manufactured cigars, nd the latter were made under climatic conditions hat would prolong the ripening process. Practically o wrapper tobacco is grown in Mexico; the leaf is ll "filler." "This is a virtue to those who like a rong cigar, easily smoked, but it is a defect for the eneral consumer, who likes a milder article which he an smoke all day." Tobacco of the Havana quality an now be raised only in Mexico, which "seems soon estined to wear the mantle of Havana in tobacco roduction, and, once secured, it is safe to predict hat it will never pass away, for the soil of the obacco region is so deep as to be practieally inexaustible, being from 8ft. to 20ft. in depth, and in ome places even 30ft. Moreover, its extent is robably a hundred times that of the Cuban tobacco egion." It is suggested that the result of the icreasing cultivation of Havana tobacco in Mexico ill be to put Havana cigars within the reach of all, ven though the Cuban soil is exhausted. Germany nd Belgium are at present the chief customers of Mexico for tobacco, Great Britain coming next, and United States fourth.—*The Times.*

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

MARCH 17.—"Music in England at the Queen's Accession." By J. SPENCER CURWEN. SIR WM. CLEAVER FRANCIS ROBINSON, G.C.M.G., will preside.

MARCH 24.—"The Transmission of Power by Alternating Electric Currents." By W. B. ESSON, M.Inst.C.E. ALEXANDER SIEMENS, Member of Council, will preside.

MARCH 31.—"Cycling—Historical and Practical." By GEORGE LACY HILLIER.

APRIL 7.—"Dairy Produce and Milk Supply." By M. J. DUNSTAN, M.A., F.R.S.E. The RIGHT HON. LORD BELPER will preside.

Papers for evenings, the dates of which cannot yet be announced:—

"London Water Supply." By PERCY F. FRANKLAND, Ph.D., F.R.S.

"Silver and Prices: the Economic drain of Debtor Nations." By MORETON FREWEN, B.A.

"Children's Sight." By R. BRUDENELL CARTER, F.R.C.S.

"Fireproof Construction." By THOMAS POTTER.

"Motor Traffic: Technical Considerations." By Sir DAVID SALOMONS, Bart.

INDIAN SECTION.

MARCH 25, at 8 p.m.—"The Cultivation and Manufacture of Rhea Fibre." By THOMAS BARRACLOUGH. SIR WILLIAM HENRY HOULDSWORTH, Bart., M.P., will preside.

APRIL 1, at 4.30 p.m.—"A Visit to Russian Central Asia." By MICHAEL FRANCIS O'DWYER, I.C.S. (Assistant Commissioner in the Punjab).

MAY 6, at 4.30 p.m. — "Kafiristan: its Manners and Customs." By SIR GEORGE SCOTT ROBERTSON, K.C.S.I. (late British Agent at Chitral). FIELD-MARSHAL LORD ROBERTS, V.C., G.C.B., G.C.S.I., G.C.I.E., will preside.

MAY 20, at 4.30 p.m.—"India and its Commerce." By SIR JAMES LYLE MACKAY, K.C.I.E. (late President of the Bengal Chamber of Commerce).

The meetings of April 1, and May 6 and 20 will be held at the Society of Arts; and that of March 25 at the Imperial Institute.

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

MARCH 16. — "The Progress of the British

Colonies of Australasia during the Sixty Years of Her Majesty's Reign." By JAMES BONWICK. Sir FREDERICK YOUNG, K.C.M.G., will preside.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock :—

MARCH 30.—"Lead-work." By W. R. LETHABY.

APRIL 27.—"Delft Ware." By Dr. J. W. L. GLAISHER, F.R.S.

MAY 11.—"A Half Century of Line Engraving, 1780-1830." By GEORGE CLULOW.

CANTOR LECTURES.

Monday Evenings, at half-past 4 o'clock :—

PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., "Alloys." Four Lectures.

LECTURE I.—MARCH 15.—Alloys which are solutions of the constituent metals, and those which contain chemical compounds.

LECTURE II.—MARCH 22.—The diffusion of liquid and solid metals.

LECTURE III.—MARCH 29.—Steel and cast-iron, considered as carbon—Iron alloys.

LECTURE IV.—APRIL 5.—Advances in our knowledge of alloys since the last course of Cantor Lectures "on Alloys" was delivered, in 1893.

LEWIS FOREMAN DAY, "Design in Lettering." Four Lectures.
May 3, 10, 17, 24.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 15...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Cantor Lectures.) Prof. W. Chandler Roberts-Austen, "Alloys."

East India Association, Town Hall, Westminster S.W., 3½ p.m. Dr. Robert N. Cust, "The Treatmemt of Natives of British India in South Africa."

Imperial Institute, South Kensington, S.W., 8½ p.m. Prof. J. J. Hummel, "Some Indian Dye-stuffs."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. Alfred Hill, "Characteristics of Meat, Fish, Vegetables, &c., unfit for Food."

British Architects, 9, Conduit-street, W., 8 p.m. W. H. St. John Hope, "Heraldry in English Mediæval Architecture."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Lecture on Illustrated Counties, "Rural Middlesex."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Dr. Kidd, "Creation or Evolution."

TUESDAY, MARCH 16....SOCIETY OF ARTS, John-street Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. James Bonwick, "The Progress of the British Colonies of Australasia durlng the Sixty Years of Her Majesty's Reign."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. D. Waller, "Animal Electricity." (Lecture IX.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Statistical, in the Theatre of the United Service Institution, Whitehall, S.W., 5½ p.m. Mr. Frederick C. Danvers, "Agriculture in Essex during the Past Fifty Years: as Exemplified by the Records of One Farm, with Special Reference to the Prices of Corn and the Conditions of Labour."

Pathological, 20, Hanover-square, W., 8½ p.m.

Photographic, 12, Hanover-square, W., 8 p.m.

Self-Propelled Traffic Association, Colquitt-street, Liverpool, 8 p.m. Mr. M. Legros, "Traction by Compressed Coal-Gas."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. C. I. Forsyth Major, "The Malagasy Rodent-genus *Brachyuromys* and its Affinities." 2. Dr. R. Collett, "A Collection of Mammals from North and North-West Australia." 3. Mr. A. Smith Woodward, "Vertebrate Palæontology in South America: Notes of a Recent Tour." 4 Mr. P. L. Sclater, "The Distribution of Marin Mammals."

Dundee Institute of Architecture, Science and Art 8 p.m. Mr. J. A. Williamson, "Architecture i the Reign of the Queen."

WEDNESDAY, MARCH 17...SOCIETY OF ARTS, John-street Adelphi, W.C., 8 p.m. Mr. J, Spencer Curwen "Music in England at the Queen's Accession."

Meteorological, 25, Great George-street, S.W., p.m. 1. Mr. G. J. Symons, "Meteorologica Observations in 1837 and 1897." 2. Exhibitio of Meteorological Instruments in use in 1837 and i 1897.

Microscopical, 20, Hanover-square, W., 8 p.m 1. Mr. J. L. Williams, "The Formation an Structure of Dental Enamel." 2. Mr. A. E Wright, "A new Method of Measuring an Counting Microscopic Objects."

United Service Institute, Whitehall, S.W., 3½ p.m Colonel Lonsdale Hale, "The Professional Stud of Military History."

Archæological Association, 32, Sackville-street, W 8 p.m.

THURSDAY, MARCH 18...Royal, Burlington-house, W., 4½ p.m

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Sir Joh Lubbock, "Further Observations on Stipules. 2. Mr. W. C. Worsdell, "The Origin of Trans fusion-Tissue in the Leaves of Gymnospermou Plants."

Chemical, Burlington-house, W., 8 p.m. 1. D Alexander Scott, "The Atomic Weight of Carbon. 2. "A New Series of Miacosulphates of the Vitri Group." 3. Messrs. Wyndham R. Dunstan ar Ernest Goulding, "The Action of Alkyl haloids o Aldoximes and Ketoximes."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m Mr. H. R. Kenwood, "Infectious Diseases ar Methods of Infection."

Royal Institution, Albemarle-street, W., 3 p.m Prof. Percy Gardner, "Greek History and Exta Monuments." (Lecture III.)

Historical, 28, Jermyn-street, S.W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p. Dr. H. R. Mill, "Geographical Pictures, wi Hints to Amateurs."

FRIDAY, MARCH 19...Royal Institution, Albemarle-street, W 8 p m. Weekly Meeting. 9 p.m. Sir Edward Thompson, "Greek and Latin Palæography."

Quekett Microscopica Club, 20, Hanover-squar W.C., 8 p.m.

SATURDAY, MARCH 20...Royal Institution, Albemarle-stree W., 3 p.m. Lord Rayleigh, "Electricity and Ele trical Vibrations." (Lecture III.)

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FRIDAY, MARCH 19, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS IN PRACTICAL MUSIC.

The date for the commencement of these Examinations will be postponed from the 21st to the 28th of June, in consequence of Tuesday, June 22nd, having been fixed for Her Majesty's Jubilee Celebrations.

CANTOR LECTURES.

Professor W. Chandler Roberts-Austen, C.B., F.R.S., delivered the first lecture of his course on "Alloys," on Monday afternoon, 15th nst.

The lectures will be printed in the *Journal* during the summer recess.

FOREIGN & COLONIAL SECTION.

Tuesday, March 16, 1897; Sir Frederick Young, K.C.M.G., in the chair.

The paper read was "The Progress of the British Colonies of Australasia during the sixty years of Her Majesty's reign," by James Bonwick.

The paper and report of the discussion will be published in the next number of the *Journal.*

Proceedings of the Society.

INDIAN SECTION.

March 11, 1897: The Right Hon. Lord George Hamilton, M.P., Secretary of State or India, in the chair.

The Secretary of the Section announced that a elegram had been received from H.R.H. the Duke of Connaught, at Aldershot, regretting that important military duties prevented his being present. The Lord Mayor, General Richard Strachey and Sir Henry Cunningham had written saying they were unable to attend owing to pressing engagements elsewhere.

The Chairman, in introducing Sir Charles Elliott, said he was a member of the Anglo-Indian service, who had had a most distinguished career in India, having filled many administrative posts, and he was probably the highest authority on famine administration in the world. Twenty years ago he was specially appointed by the Indian Government a Famine Commissioner to superintend the operations in Mysore, and subsequently he occupied a similar position in other parts of India, and afterwards became Secretary to the Famine Commission, and took a leading part in framing its report. Since then he had occupied many important positions, including the Lieutenant-Governorship of Bengal, and had on more than one occasion to carry into operation portions of the Famine Code, which he had so large a part in framing.

The paper read was—

ON MEASURES TAKEN BY GOVERNMENT FOR THE PREVENTION OF FAMINE IN INDIA.

By Sir Charles A. Elliott, K.C.S.I.

Preface.

When I first offered, some six months ago, to prepare a paper for this Society on the subject of Famine Prevention, it was known that there had been a serious deficiency in the rainfall of 1896, but the extent of the disaster had not declared itself, and the severity of its incidence could not be foreseen. I proposed then to confine myself to a description of the measures recommended by the Famine Committee in 1880, and the manner in which they had been carried out by the Government of India up to the present date. Since then, full reports have been received from the Government of India and the Provincial Governments, showing the wide area over which the drought prevailed, the great loss of crops which it entailed, and the distress into which the people have been plunged. Public attention has been arrested over the whole of England by the accounts of this great calamity, interest and sympathy have been raised to a high pitch, and a magnificent contribution has been, and is still being, collected for the relief of the sufferers. It has, therefore, seemed expedient to enlarge the original plan of this address by adding to it some account of the present famine, comparing it with previous disasters of the same kind, and showing how far the preventive measures, and the organisation which has been prepared, are succeeding in combating the distress and providing requisite relief.

In dealing with the suggestions of the Famine Commission, I propose first to describe the means adopted for the protection of the country against famine; next, those intended for the direct prevention and relief of famine; and, thirdly, the steps taken for indirect relief by improving agriculture, strengthening the power of the landed classes to resist a scarcity, and organising the different official departments which are called on to assist in the struggle.

Sense in which the words Prevention and Protection are used.—It would have seemed to me unnecessary to explain the sense in which the term prohibition and prevention are used, had it not been for a bitter and ignorant article which appeared in the *Investors' Review* for March, and which asserts that these measures have been mistaken or fraudulent, because they have not averted the present famine. The answer to this is that a famine arising from drought is a calamity which human efforts are unavailing to prevent. Irrigation is the only possible remedy for drought, and there are large tracts where irrigation cannot be brought in. Railways are protective only in the sense that they enable food to be carried where otherwise it could not penetrate; administrative reform is protective so far as it prepares the official staff to take up a defined and formulated course of action; agricultural improvements are protective as putting the agricultural classes into a better position to resist the effects of a loss of their crops. More than this, the terms I have used do not profess to convey.

CANALS.

As the immediate cause of famine in India has always been the loss of crops from drought, arising from the failure of the rains, so the only mode of affording protection against famine is the provision of the means of artificial irrigation. This can be effected in three ways, by wells, by tanks, and by canals. Of these three means, the construction of canals is obviously the one most suitable for the operations of Government, as on account of the great scale of the work, its cost, and the engineering talent and experience required for success, it can hardly be undertaken by private persons. The Famine Commission pointed out that the beneficial effects of such works should not be judged by their financial success alone, though taken as a whole, the canals do produce a revenue which covers the interest on the capital outlay. The true value of irrigation works will be best understood by considering the protection afforded by them in years of drought, the saving of human life, the avoidance of loss of revenue and of expenditure on famine relief. Also in years of average rainfall they give certainty to all agricultural operations, increase the out-turn per acre of all crops, and enable more valuable crops to be grown. It may be broadly calculated that the value of the crops which would have perished if unwatered, or would not have been sown at all if the canals had not existed, equals in each ordinary year at least half the capital expended on them. Canals, however, cannot be constructed everywhere. For success in the construction of a canal three conditions are essential: one is that the supply of water in the river to be tapped should be sufficient and permanent; the second, that the tract to be irrigated should be such that the water supplied will not turn it into a swamp, so substituting malaria for famine; the third that the water can be conveyed to the land at such a cost that a moderate rate will produce a fair interest on the capital expended. There are not many tracts which satisfy these conditions, and the Famine Commission only saw its way to making specific recommendations in a certain number of cases.

Punjab.—In the Punjab they advised the remodelling of the West Jumna Canal and its extension by a fresh branch to Sirsa the opening of the Sirhind Canal, the construction of which had lingered over twelve years, and a gradual extension of canal (mostly inundation rather than perennial from the Chenab and Sutlej. But they deprecated too hasty development of such work lest the increase of population should no keep up with them. Experience has shown this fear to be unfounded. Want of fund has been a sufficient check on untimely expansion, and an admirable system has been evolved, with which the name of Sir James Lyal is worthily connected, by which as new wast land is opened up and rendered culturable b the canals, it is blocked out and parcelled of in an orderly manner among the expectan population. The Sirhind Canal has been finished at a cost of 2,400,000 Rx*, and irri ited 685,000 acres in the last year of drought, 91-2. The West Jumna Canal has been modelled, and the Sirsa Branch added, at the st of 880,000 Rx., but it has not of late ars irrigated as large an area as that which, der great pressure, it watered in 1877-8. he Swat River Canal, the Sohag Para, the henab, and the Sidhnai have all been con-ructed since 1877-8, costing about one and two-irds millions of Rx., and irrigating 575,000 res; and the great Jhelum project has now een started on similar lines to those of the henab Canal. It is in this province more than y other that the conditions requisite for canal onstruction are found; an unlimited supply of ater from snow-fed rivers, and soil (excepting e tract bordering on the Jumna) which is orthless when dry, but productive when water applied, and so valuable as to pay easily the ost of bringing the water, while the climate so rainless that there is no fear of the round becoming water-logged and malarious. he Punjab canals had, in 1895, earned 500,000 Rx. over and above the interest n the cost of construction.

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* Rx. stands for tens of rupees, or "rupee-pounds,"

North-West Provinces.—In the North-West rovinces, they recommended the completion of e Lower Ganges Canal, the construction of e Betwa and Ken Canals in Bundelkhand, nd a modification of the scheme for the ardha Canal in Oudh. The Lower Ganges anal scheme has been carried out at a cost f nearly two millions of Rx. since 1877, nd the area irrigated by it and the Upper anges Canal, which was 1,045,000 acres in at year, rose to 1,494,000 acres in the year 891-2, when the rainfall was deficient. t fell, however, as low as 783,000 acres in 894-5 when rain was abundant, thus giving a seful object-lesson as to the value of such orks in the time of drought, and of their un-ertainty as a financial investment when arried out in a region where the rainfall is sually or often sufficient for agriculture. The wo Bundelkhand projects had been long post-oned from doubt whether they would prove nancially profitable, but this part of the ountry has often suffered severely from amine, and is now the area where the distress s more acute than anywhere else in India. he Betwa Canal has been finished at a cost f nearly 500,000 Rx., but the area irri-ated (estimated at 98,000 acres) has never xceeded 34,000 acres, and has never paid he interest on the capital expended. It is, owever, probable that we shall learn that it as been of the greatest benefit in the present crisis. The Ken Canal has not been undertaken; it would have run through the Banda district, where, at the present moment, a larger proportion of the population is requiring famine relief than in any other district in India, and I trust that we shall hear that the experience of the present calamity will lead to its early construction. Against any loss incurred in it and the Betwa project may be set the fact that the canals in this province, taken as a whole, have earned over a million of Rx. above the interest on capital expended. Nor has even the modified Sardha scheme been put in hand, but there is good reason to believe that though it would have saved the western half of Oudh from much distress in this year, it might have produced evils in other years, by water-logging the country, which would have counterbalanced that benefit.

Bengal.—In Bengal suggestions were made for improving the working of the Sone Canal, completing the development of the Orissa system and carrying out irrigation works on a large scale from the river Gandak. The latter project has not been taken up or even worked out, and I am now satisfied that it is not desirable from either a financial or a protective point of view; but something is done and more might be done towards utilising the water of the smaller streams which enter Bihar from Nepal. The Sone Canal system is the only one which can be said to be even moderately successful in Bengal. Three-quarters of a million of Rx. have been spent on it since 1877, and its irrigated area has risen from 241,000 acres to 474,000 in 1891-2; and though it has very rarely paid the interest on its capital, it has in the present year saved the Shahabad district from famine. Three-quarters of a million of rupees have been spent since 1877 on developing the Orissa Canals, but the water is taken reluctantly and only used for special crops, unless in years of deficient rainfall; the irrigated area, which was 98,000 acres in 1877, only stood at 103,000 acres in 1893-4, though it rose to the figure of 180,000 acres in 1890-1. It has never paid the interest on its outlay, and often (as, for instance, in 1894-5) has not covered its working expenses.

Bombay.—The outlook for canal projects in Bombay is not promising, as there are no perennial snow-fed rivers, and the staple crops are raised in ordinary years without irrigation. Accordingly the Famine Commission abstained from making any definite suggestions for the future, and wrote doubtfully of the prospects of the existing schemes. They said that, though 200,000 acres of the most endangered parts of the province had been protected from future famine, irrigation works in the Deccan must be prosecuted with caution, if they are to be justified by financial success. Since 1877, one million of Rx. has been expended, and the irrigating area has risen from 15,000 acres in 1877 to 68,000 acres in 1891-2, which is the highest year on record; but, taken as a whole, they hardly do more than pay their working expenses. All of them have, however, and especially the Nira Canal, proved of much benefit in the year of scarcity 1891-2, and are probably doing great good at the present season.

Sindh.—In Sindh, the Commission wrote, "there is no rainfall, so there is no possibility of famine from drought." It is pre-eminently a country where irrigation from the Indus may be carried on to an almost unlimited extent; great areas of waste dry land are ready for cultivation if water is brought to them; there is no fear of excessive irrigation producing malarious swamps; and the only check on expansion is the sparseness of the population. Nearly 500,000 Rx. have been spent in enlarging the Sindh Canals since 1877, and the area irrigated by them has increased from 223,000 acres in that year to 607,000 acres in 1894-5. They have earned 250,000 Rx. beyond the interest on the capital outlay.

Madras.—In the case of Madras, where the great irrigation systems in the Deltas of the Godaveri, Kistna, and Cavari are leading instances of the immense advantages of well-devised irrigation works to the State and the people, the Famine Commission recommended the completion and extension of tho systems, as well as the construction of fi other projects—the Tungabhadra Canal i Bellary, the Kistnagiri reservoir in Salem, th Periyar scheme in Madura, the Rushikulya Ganjam, and the Sangam in Nellore. Th three latter projects have been carried ou The Rushikulya and Sangam have co 750,000 Rx. and irrigated, in 1894-5, 104,0 acres. The great Periyar project, by whi a river flowing westward into Travancore diverted, passed through a tunnel in the hill and its waters sent eastward to replenish t tanks of Madura, has been carried out at cost of 750,000 Rx., and was opened in 189 but no returns have yet been received of t increased area irrigated from this sourc On the Godaveri, Kistna, and Cavari delt over 1,250,000 Rx. has been expended sin 1877, and the irrigated area has risen fro 1,646,000 acres to 2,270,000 acres. Th Karnul Canal was also purchased fro the Madras Irrigation Company as the on way of securing the proper utilisation the water, though it was not possible th it should prove a financial success; it ha never irrigated more than 73,000 acres, an has not in the course of years cover its working expenses, much less recoup the interest in the immense price paid for Still, in spite of this and some other financi failures, the Madras canals have as a who been splendidly successful, and have earned the State, up to 1895, five and a half millio of Rx. above the interest on capital outlay.

Province.	Capital outlay up to 1877-8. *	Capital outlay up to 1894-5. *	Irrigated area in 1877-8. *	Irrigated area in the highest year between 1891 and 1895. *	Mileage in operation.	
					1877-8.	1894-5.
	Rx.	Rx.	Acres.	Acres.	Miles.	Miles.
Punjab	3,689	7,651	775	1,963 (*a*)	2,287 (*c*)	7,694
N.W.P.	5,388	8,075	1,415	1,913 (*a*)	5,212	10,467
Bengal	4,590	6,160	360	736 (*a*)	1,824	3,333
Sindh	494	1,001	223	607 (*b*)	422	724
Bombay	914	1,899	15	68 (*a*)	354 (*c*)	757
Madras	3,341	6,703	1,787	2,521 (*b*)	6,649 (*c*)	7,600
Total	18,416	31,489	4,575	7,808	16,748	30,575

* Three o's omitted.

a. Figures for 1891-2.

b. Figures for 1894-5.

c. Figures for 1880-1; those for 1877-8 not being on record.

To sum up under this head, the preceding able compares for each province the capital utlay on the great canals in 1877-8 and at he end of 1894-5, the area irrigated by them in 877-8, and the corresponding figure for the ear of largest irrigation between 1891 and 895. This last figure has been taken as howing more truly for Upper India the proective capacity of the canals when the water s most needed than if I had given the figures or 1894-5, whenthe abundant rainfall militated gainst their full employment.

Thirteen million of Rx. have been expended n the construction and development of the ajor canals since 1877-8, the mileage of hese canals and their distributaries has inreased by about 14,000 miles, and the rea irrigated by them, when used to their reatest extent, has increased by 3,233,000 cres. No doubt the return of the present ear will show a still larger area. Some ,000,000 Rx. have been spent besides on ninor canals and irrigation works, the area vatered by which exceeds 2,000,000 acres.

WELLS.

Next in importance to canals, or perhaps of qual importance with them, as a means of roviding artificial irrigation to the crops, are vells. Wherever there is a water-bearing tratum below, but not far below the surface, eparated from it by clay or other soft soil and ot by rock, wells can be dug with little diffiulty or expense, and the central alluvial lain of Northern India—between Delhi and Benares—is riddled like a sieve with innumerble water holes from ten to fifty feet deep. But where rice is the main crop, where rain nd surface moisture are plentiful, as in most arts of Bengal, where the water is too far elow the surface as in most of the Punjab, or vhere the subsoil is a stratum of rock, as in nost of Central and Southern India, wells annot be sunk with advantage or without great expense; and it has been calculated by he Agricultural Department that the tracts vhere well-irrigation is not needed or is not racticable, or where canal irrigation is more dvantageous, occupy about ten-elevenths f the entire area of British India, leaving nly parts of Bihar and of the Punjab, he whole of the North-West Provinces and arts of Bombay and Madras, as the area uitable for well extension. The Famine Comnission held that there were numerous localiies in which wells might profitably be made, ut in which their construction had hitherto been prevented by the absence of capital, or by the conflicting relations of tenants and landlords. They urged that systematic steps should be taken by Government to supply capital or to overcome the difficulties in the way of mutual co-operation, and they supported a proposal of the Government of the North-West Provinces to start an experiment by appointing a special officer to make a thorough examination of certain tracts, in order to decide whether wells could advantageously be constructed or not, and to furnish the cultivators with necessary engineering assistance and advances of money; or else that Government should, with the consent of the proprietors, construct the wells and charge a rate on the land irrigated by them. This experiment was carried out, but though valuable information was obtained, the results were found to be incommensurate with the cost; State labour was too expensive, and a knowledge of the local conditions, such as could only be obtained by resident agriculturists, was indispensable for success. It was decided that direct State assistance could only be given by the loan of boring apparatus, and by the encouragement of agricultural loans. This policy has, therefore, been accepted and carried out. The area irrigated by wells was estimated by the Commission, on very imperfect data, at about 11,500,000 acres, but this was probably in excess of the truth. In 1885-6 the village records organised and perfected under Sir E. Buck's system, which I shall describe later on, returned the well-irrigated area as 8,750,000 acres; and in 1891-2 the same records showed an area of 10,140,000 acres. There has been everywhere much activity in well-sinking, especially in times of drought. The Madras Government in the scarcity of 1891-2 distributed large advances which led to the digging of 12,000 wells. We have it on record that last year, with similar help from the Government of the North-West Provinces, about 225,000 wells were sunk in order to cope with the expected famine.

GENERAL RESULTS OF IRRIGATION.

Including the use of water brought from tanks and streams, it is estimated that out of a total cultivated area of 180,000,000 acres. 29,000,000 are irrigated, and so placed beyond the risks arising from any ordinary drought, The food raised in this area may be roughly estimated at 20,000,000 tons, or sufficient in times of famine to feed 120,000,000 people.

In other words, the irrigated area raises half the food supply required by the entire country.

RAILWAYS.

The next great class of measures to be treated of is the construction of railways, which come partly under the head of Famine Prevention, because many an incipient scarcity has been stopped by the importation of food supplies poured in by the railways, and partly under the head of direct Famine Relief, because when a famine exists, it is to the railways that we principally look for carrying food from those parts of the country which have it, to those which have not. But for the railways which existed in 1877, there might in many cases have been a complete failure of food for a time, and the task of affording relief would have been impossible. The country is now experiencing the same beneficial results on a much larger scale, owing to the great increase which has been made in the provision of railway communication within the last twenty years.

Basis of Estimated Requirements.—The Famine Commission calculated that assuming a line of railway to be 300 miles long and to be able to provide for a tract 25 miles broad on either side, it would be called on to serve an area of 15,000 square miles, containing at 250 to the square mile, 3,750,000 people. Reckoning a ton of food to be sufficient, in famine times, for six people for a year, this population would require 625,000 tons to feed them for a year, and this could be conveyed in six broad-gauge or ten metre-gauge train loads (of 300 and 175 tons respectively) a day, which is well within the power of any railway. Even if the density of population is double or treble the above figure, there would be no difficulty in carrying the food they require, for it need never be assumed that the entire food supply of any tract is absolutely exhausted and that the whole population are forced to depend solely on the railway. Working on this basis of 300 miles of railway for 15,000 square miles, it was calculated that for the 1,000,000 square miles of British India a length of 20,000 miles of railway was requisite, and as there were 8,300 miles open at that time, preparation should be made for constructing 11,000 or 12,000 additional miles. But putting aside the mountainous and desert districts, and those naturally safe from danger of famine, it was held that the addition of 5,000 miles would go far to remove all future risk of serious difficulty in supplying food to any part of any district in the whole country.

Railways Suggested.—The specific recommendations of the Famine Commission as to the tracts to be protected by new railways, and the actual lines which have been constructed since 1877 to meet these requirements are as follows :—

Recommendations of Famine Commission.	Lines Constructed Since 1877.	Miles.
In the Punjab, improved transport is required between Delhi and the districts north and west of that city, which are irrigated by the West Jumna Canal, and which will afford a certain source of supply to the arid region to the west and south.	Delhi—Kalka …………	162
	Ambala—Bhatinda …	108
	Bewari—Ferozepur ..	241
	(North-West Railway) Multan—Hyderabad	540
	Wazirabad—Lyallpur	96
The Province of Bundelkhand between the Jumna and the G.I.P. Railway.	Indian Midland Railway—joining Agra, Cawnpore and Manihpur, with Jhansi, Bhopal and Itarsi …	678
North Bihar and North Bengal.	Bengal and North-West Railway ……	414
	Tirhoot State Railway	341
	North Bengal Railway (E.B.S.R.) ……	474
Railway from Calcutta to Madras, through Cuttack and the Godaveri and Kistna Deltas.	East Coast Railway (incomplete, 354 miles now open)……	547
Railway from the Godaveri and Kistna, and Nellor to Karnul, Cuddapah and Cuddalore.	Bezwada to Hyderabad ……………………	22
	Bezwada to Guntakul	27
	Nellore to Pakala……	108
	South Indian Extension from Guntakul to Bangalore and Dharveram to Villapuram	45
Railway through Eastern Districts of Mysore to Dharwar.	South Maratta, from Bangalore to Dharwar.	1,04
Railway communication in the South Maratta country, with access to the sea at Goa or Karwar.	South Maratta to Poona, Sholapur and Guntakul ……………	
	West of India Portuguese to Goa ………	5
		5,72

Thus the scheme of the Famine Commissio has been carried out to the letter by the construction of 5,726 miles of railway, and it wil be noticed that the lines thus laid out pas through most of the parts of India now especially suffering from famine or scarcity—Bundelkhand, North Bihar, the South Punjab, the Deccan Districts of Bombay and Madras; and th Lieutenant-Governor of Bengal recently wrot that no town in North Bihar was more than 25 miles from a railway. Altogether 19,677 miles of railway were open on the 1st April, 1896, an increase of 11,409 beyond the figure of 1877: and the capital outlay since 1879 has been 142,000,000 Rx., or at the rate of 8,500,000 a year. The return on this outlay in 1895-6 was 5·78 per cent.

RATES OF FREIGHT ON FOOD GRAIN.

The Commission further advocated the reduction of freight rates to the lowest figure which was compatible with profitable working, but discouraged a proposal to reduce the rate on food grain specially in time of famine, mainly on the ground that the rolling stock was fully employed in famine times, and it would have been useless to attempt to carry any further loads. At that time the long distance rates were from a quarter to one-sixth of a pie per maund (say seven-eighths to nine-sixteenths of a penny per ton) per mile. Since 1880 there has been a great reduction in rates on food grains, which now range for distances over 450 miles, from one-eighth to one-tenth of a pie, or from ·22 to ·28 pence per ton per mile. A fairly uniform classification of goods has been introduced on all State railways, and railways over which the Government has any control, and maxima and minima have been fixed for each class. The Indian Midland Railway has largely reduced its rates since last year, in some cases as much as 50 per cent. I learn from General Strachey that in January and February the East Indian Railway Company carried 141,150 tons of food up country, or sufficient to feed five million people for two months. This is more than double the number now on relief in Upper India. This grain is carried 800 miles at the cost of 2½ pies per seer, so that if the grain costs 8 seers per rupee, a high famine rate, it can be carried 800 miles for one-tenth of its cost price. General Strachey stated that American wheat is selling now at Liverpool at 6s. 8d. to 7s. per 100 lbs. of grain. If sold in Calcutta at the same rate, it can be carried 800 miles from the port and sold at 8 seers per rupee.

THE FAMINE GRANT.

The close of this account of what has been done to protect the country against famine by public works is a convenient place in which to mention a cognate measure, though not one of those suggested by the Famine Commission, the so-called Famine Insurance Fund. Seldom has a term been used which has been more unfortunate in leading to misapprehension and confusion of thought, and several attempts have been made, with more or less success, to remove the mistaken impression from the minds of the public. The Secretary of State for India recently explained the true state of the case with the utmost lucidity, but in spite of this the editor of the *Investors' Review*, in the article to which I have already referred, repeats the old false charges with vehement virulence. "The money," he says, "was originally set aside to form a fund, to be something on hand and available in an emergency." It is curious that a man who pretends to guide the City of London in financial matters should support the crazy notion that a Government which habitually borrows money for remunerative public works could entertain such a scheme as that of locking up a reserve of cash against an emergency. Sir John Strachey wrote*, in 1888, "It has been supposed that a separate fund was constituted into which certain revenues were to be paid, and which could only be drawn upon for a specific purpose. No such impracticable notion was ever entertained, and every idea of the kind was from the first repudiated by the Government and by myself, who was responsible for the original scheme. The Famine Insurance Fund, of which people have so often talked, never existed." The real origin and meaning of the measure was this. It was found that during the ten years preceding 1877 the Government had spent about 15,000,000 Rx. as famine relief. It was argued that a similar expenditure might be required in the future, and, therefore, that the Government ought to raise a surplus of 1,500,000 Rx. every year, in order to pay off 15,000,000 Rx. of debt in ten years and start free of accumulated debt to meet the next famine. Afterwards this intention was so far modified that it was decided that a portion of the money should be expended on the construction of railways and canals required for the protection of districts specially liable to famine. But the original idea was never altered, which was that the income and expenditure of the Government should be proportioned so as to show a balance of 1,500,000 Rx. to be devoted in one way or another to famine relief. Hence the Indian Budget always aims at a surplus, and if there is not a surplus of 1,500,000 rupees there is said to be a deficit, which is one of the reasons why the financial position of India, which really, barring the loss from the fall in the rupees, is one of the soundest in the world, is perpetually misunderstood and decried. It is obvious that though the Finance Minister may always aim at a surplus, he may not always succeed in obtaining it; and for five years, from 1886 to 1891, it was found impossible to secure the entire amount without putting on fresh taxation. During eight years the wished-for surplus has been obtained, but in 1894 it was decided that as so much had been done to construct railways in the most exposed parts of the country, and to provide canals, that it was reasonable to frame a lower estimate of the cost of future famine relief and to reduce the surplus aimed at to one million of Rx. Thus in the sixteen years which have elapsed since 1881, during which there should, if the objective had been reached, have accrued twenty-two and a half millions of Rx. of surplus, the actual amount has been eighteen and two-thirds millions of Rx. Of this five and one-third millions of Rx. has been spent in the reduction of debt, eleven millions of Rx. on protective railways, nearly two millions o Rx. on canals, and about one-third of a million of Rx. on famine relief.

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* "India," p. 184.

Years.	Famine Relief.	Construction of Protective Irrigation Works.	Construction of Protective Railways.		Reduction or avoidance of Debt.	Total.
			Charged under Famine Relief and Insurance.	Charged under Railway Revenue Account.		
	Rx.	Rx.	Rx.	Rx.	Rx.	Rx.
1881-82	34,883	135,449	682,403	—	715,151	1,567,886
1882-83	22,103	263,443	— 133,129	—	1,343,555	1,495,972
1883-84	9,205	283,223	649,248	—	581,137	1,522,813
1884-85	7,350	253,046	946,457	—	341,504	1,548,357
1885-86	40,695	186,807	589,000	29,271	683,498	1,529,271
1886-87	1,041	107,979	200,000	151,812	—	460,832
1887-88	402	91,006	—	285,199	—	376,607
1888-89	7,799	70,537	—	430,182	—	508,518
1889-90	68,288	71,457	—	462,009	460,255	1,062,009
1890-91	5,579	74,392	—	482,350	520,029	1,082,350
1891-92	23,423	77,931	484,795	231,681	682,170	1,500,000
1892-93	70,841	60,793	984,469	383,897	—	1,500,000
1893-94	496	56,351	1,060,954	371,768	—	1,489,569
1894-95	10,258	43,110	556,867	389,765	—	1,000,000
Revised Estimate, 1895-96	10,500	40,200	534,800	414,500	—	1,000,000
Budget, 1896-97....	75,000	50,000	473,500	401,500	—	1,000,000
Total of 16 years..	387,863	1,865,724	7,029,364	4,033,934	5,327,299	18,644,184

THE FAMINE CODE.

We come now to measures of direct relief to be undertaken when the land is visited by famine, and the measure which the Commission put in the forefront of its recommendations on this head was the preparation of a Famine Code. In earlier times orders securing uniformity of system and prescribing the duties of each class of officers were promulgated as occasion arose, but it soon became obvious that a permanent body of rules should be drawn up. "The duties i volved in relief measures are complicated a multifarious; their successful performan necessitates the utilisation of large stores accumulated experience and a carefully-co sidered and prepared plan; they cannot safe be left to individual energy and resource, be dealt with in a system improvised or when the emergency has arisen. Prom and decided action in carrying out the measures is of primary importance, and considering well beforehand the principles that should guide them much of that hesitation and uncertainty of purpose which have been found to be so detrimental in the past, will be avoided in future."

The principles on which this code was to be prepared were grouped under two heads:—(*a*) Provision of relief work for the able-bodied; (*b*) Gratuitous relief for the aged, weak, and sickly, in their homes or in poor-houses.

Tests.—The first of these principles involves the only test of want which the Commission thought it desirable to enforce, the labour test, which demands from each person in return for a wage sufficient for the purpose of maintenance, labour commensurate with his powers. This system provides a method of relief intelligible to the great mass of the population and suitable to their habits of life; it affords the means of ascertaining necessity, detecting imposition, and procuring for the State some useful return for its expenditure; it avoids to a large extent the demoralising influence of purely eleemosynary aid. On these grounds the Commission held that it is the safest and most efficacious form of State help, and that, in the language of Turgot, "the best and most useful kind of alms consists in providing means of earning them." Of the two forms of gratuitous relief, each has certain advantages and is liable to certain dangers. If such relief is made conditional on residence in a poor-house, the test would not only keep away those not in want, but has been found to deter many who are really suffering; the feeling of people in many parts of India towards this form of relief amounts to repulsion, and when the famine is acute the numbers are so great as to lead to demoralisation, and to the breaking up of the links which hold the village community together. On the other hand, the distribution of relief to people in their own homes, though far more popular, is liable to become expensive and indiscriminating; the difficulty of distinguishing worthy from unworthy applicants is great, and the subordinate officials through whom the relief has to be administered cannot be fully trusted. The system can only be safely worked under an elaborate system of village inspection by trustworthy officers.

Contents of the Famine Code.—The first complete Famine Code was drawn up by myself, when I was Famine Commissioner in Mysore, and is printed as an appendix to the Mysore Famine Report. The draft of a model code, based partly upon this code and partly on other suggestions received by the Famine Commission was attached to their Report. When that Report reached India a commission of experts was appointed in 1882, and a provisional famine code drawn up which was circulated to all Local Governments, by whom provincial codes were drawn up modifying, as far as was necessary, the general provision so as to make them agree with special local requirements and peculiarities. These again have been altered and enlarged from time to time as further experience in dealing with famine was gained. For instance, in 1892, after the scarcity of the preceding winter, I completely revised the Bengal code and introduced into it all such developments as our experience of that year, or the experience of other provinces up to that date, showed to be advisable. The North-West Province code was revised in 1895, and is perhaps the most complete model of a provisional code that now exists, and it will be interesting and instructive to give a brief sketch of its arrangement and contents. It is contained in twenty-four pages with a number of appendices. It begins by setting forth the duties of all classes of officials: (1) in ordinary times as regards collecting information as to the state and prospects of the crops, and preparing a programme of relief works to be ready for an emergency, (2) in times when scarcity is imminent, or especial vigilance is required; and, lastly, when famine is declared to exist. Under this latter head, which comprises the bulk of the code, it treats in detail, in thirteen chapters, of the duties of the different classes of officials, and the mode of carrying out different branches of relief. It shows how the engineer officers are to turn ordinary public works, which may at the time be on hand, and which are suitable for the purpose, into relief works, and to make provision for funds, tools, and progress reports; how the districts are to be divided into relief circles, and what the duties of the circle officers are, especially as regards provision of grain and the treatment of starving wanderers. It defines the duties of the police in respect of protecting stores of grain, visiting lanes and byways to search for starving and feeble people, and the disposal of the dead. It directs the medical officers to inspect the relief centres, to take charge of the relief hospitals, to supervise medical arrangements, and to see that a sufficient staff of hospital attendants is provided. It lays down a complete system for keeping the accounts of famine expenditure, and for providing and distributing the necessary funds. It describes exhaustively the modes in which relief is to be given. Lists of persons requiring gratuitous relief are to be drawn up by the village officers, and the relief either in grain or money is to be given by the circle officer through a committee of respectable inhabitants, chiefly to the following classes: the insane, blind, and cripples; those who are too old or weak to labour; and those who are detained in their homes by the care of children or sick relatives. Works are to be opened, as occasion requires, first as test works, and afterwards, if the influx of labourers shows these to be needed, as relief works: the labourers are to be classified according to their skill and physical strength; work is not to be paid for by contract, but tasks are to be fixed suitable to the classes of labourers; the wages paid are to be adjusted by a sliding scale to the price of food in the neighbouring market; and full details are prescribed as to the payment of labourers, the supply of food, the provision of shelter, and of hospital accommodation, the medical inspection, the hearing of complaints, the care of infants and infirm relatives of the workers, and the transfer of labourers when a work is finished. Similar and detailed instructions are given as to the construction of poor-houses, in which residence is enforced as a test for the receipt of gratuitous relief, and of State kitchens in which children are fed. Other measures are described for distributing relief to men, and more particularly to women, of respectable classes in their homes, under due precaution for the prevention of fraud; for the relief of artisans and weavers; for the establishment of orphanages, and the care of orphan or deserted children; for the protection of cattle, and the throwing open of Government forests, and the utilisation of forest produce for human or cattle food. The mere recapitulation of the chief heads of these measures, lengthy as it is, serves to show how minutely every step in the long ladder of famine relief has to be considered, in order to provide against omission or mistake or confusion which may lead to terrible disaster in dealing with such vast crowds as have to be provided for. No one but those initiated into such work can fully appreciate how much sympathetic care and organising ability are involved, how much past error and suffering are implied, in the manifold instructions as to what is or is not to be done.

Effects of Ill-organised Relief.—In order that I may put before you a living instance of what utter demoralisation and breakdown may ensue from the want of such forethought and organisation, and in spite of the most humane and benevolent intentions, I will read an extract descriptive of the condition into which a vast crowd of famine stricken wretches was brought in 1877, in the province of Mysore, by the administration of gratuitous relief in poor-houses, without the offer of employment, and without the checks and organisation provided by the present Famine Code:—

"There were at this time four large 'kitchens' in Bangalore itself, and two outside the suburbs, at which about 40,000 were being fed daily. The largest of these institutions was known as the 'Pettah kitchen.' It is a large walled enclosure with two gates, originally used as a standing place for cart waiting for hire. There were some lean-to shed outside the walls, where a few people could sleep, an sheds inside, where the food was stored and cooked No pauper was allowed inside at night. Those wh were residents of the town went to their own houses and the argument against enforcing residence on al applicants for food was that it would be hard t compel those who had houses in the town to leav them and reside in an enclosed place. But th majority of the applicants were wanderers from out side, who took shelter for the night in any place the could find—the open verandahs in front of shops, th chattrams or resting places for travellers, the temple and temple courts. These people, when they wok in the mornings, wandered about the town i troops begging at the shop doors, picking u offal and garbage in the streets, sweeping ou of the dust or mud of the grain-market th grains of rice that escaped from the bag as they were unloaded from the carts that brough them from the railway station, or shifted from plac to place. At the railway station they prowled abou the grain wagons, watching for an opportunity t steal, and controlled by a force of special police. I the cantonment they begged at the doors of charitab people, many of whom distributed broken victua from their tables, or a daily dole of food. Abo 10 o'clock they began to assemble at the gates of th different kitchen enclosures, where they were a mitted up to 12 o'clock. An officer was posted the gate to refuse admittance to those whose appea ance showed they were not in need; but where t applicants were so numerous, it was hard to do th judiciously or effectually. The majority were we and emaciated in the extreme, covered with itch a vermin, their unwashed bodies and clothes emitting fœtid effluvia. The prominent ribs, the should blades standing sharply out, the drawn-in stomac the thin arms, the legs from which all muscle and fle had gone, the large knees, the hollow eyes, and t spectral look on the face, were signs, especially amo the children and young adults, of long-continued misery and privation, the thought of which made the heart ache. All but the professional beggar had hung back to the last moment from receiving food in a manner which degraded them in their own esteem; the rest for the most part had held out till starvation had destroyed self-respect. 'The Sillidar lines' was an institution of a different kind, for here residence was insisted on. The place was originally intended as an infirmary and hospital for the most emaciated and sickly, but the crowds were too great to admit of judicious selection, and the paupers fed here were hardly in a worse condition than those in other places. The enforced residence was very unpalatable to them; although they received two liberal meals a day, they much preferred the excitement of the chances that offered themselves to beggars in the town, and no day passed without ten or twenty escapes being recorded, through the drains, or over the walls, or by the gates whenever a little confusion occurred. On the 1st September there were 2,500 people in the enclosure.

"The miseries they had gone through had degraded most of them almost below the level of reason-ng creatures. The pangs of long-endured hunger; he constant dread of a horrible death, kept off from lay to day, as it were, by accident, but always mminent and near; the anxiety lest in the often confused and disorderly distribution of food, they should be excluded altogether, or put off with half a ation, or have their food stolen from them by some stronger paupers; the depressing influence of sitting lay after day in a row to be fed; the feeling of legradation through beggary, and of loneliness in a crowd; all these influences combined to destroy the morale of the famine-stricken mass, and to reduce hem a prey to the wildest rumours and the most auseless panics. There was no feeling of gratitude r allegiance to those who were feeding them at such n expense of labour or money—only an ever present istrust and suspicion.

"The prevailing belief was that the Government meant to deport them to the Andamans, and the lightest circumstance served to awaken and give olour to this delusion. On one occasion, when the Chief Commissioner drove down to see them fed, followed by his mounted orderlies, the noise of the wheels and the clatter of the horses broke suddenly pon them as of such awful import that they rose up in terror, leaving their meal, and rushed to the gate to escape, crushing several of the weaker ones to eath in their flight. On a later occasion, when the Viceroy visited one of the largest kitchens, the same anic seized them; they did not then attempt to flee, ut sat in long lines weeping loudly, and large tears rolled down their cheeks into the food they were eating."

The public has read the reports which have ppeared from time to time in the newspapers showing the manner in which the poor-houses are organised now, and has seen the total absence from the descriptions of any such disorder or misery as existed in 1877. This is one of the chief benefits which may be ascribed to the Famine Code.

Difficulty of Transfer from Gratuitous Relief to Relief Works.—Next, as to the advantages of substituting relief on public works for relief in poor-houses, I make another extract from the Mysore Famine Report:—

"Meanwhile the work of drafting the paupers from the Pettah kitchen on to the railway works was going on actively in spite of very considerable difficulties. Everything had to be provided—tools, tool-sheds, huts for the labourers, cashiers, small change. A staff of mustering clerks and a number of similar small details had to be looked to which are easy enough when a work is started in a leisurely way under a department which is able to meet the demand made upon it, but which gave great trouble to persons who had to provide suddenly and rapidly for the employment of great crowds of undisciplined labourers. But by dint of infinite perseverance and by remaining on the work from morning till night these officers in a few days succeeded in introducing order and system on the work. It was necessary to begin at first with small numbers. On the first day about 200 men and women of the best physique were selected and, with their food carried in front of them, were induced to move outside the gate. At a little distance the tools were ranged, and they were told to work. They cried, lamented, implored to be let go, promising never to return. At last, first one and then another took up a spade and began to scratch the ground. After a little time they each got their meal and one anna in money besides a ticket, and were told to be at the same spot next day. All returned except two or three, and another party was selected from the kitchen, this time without trouble. On the third day the whole mass rose and eagerly cried to be led to the work. The result was that instead of the place in front of the kitchen being nearly deserted till 10 a.m., while the streets and lanes were crowded with beggars, thousands gathered there in the early morning, and were employed on the railway as fast as officers and tools could be procured. They began to know their gangs and their places, and to assemble at their proper places for the roll-call in the morning; and the business of payment in the evening, which for the first few days lasted far into the night, was soon reduced to reasonable limits.

"The reader has been able to form, from the description of the 'Pettah kitchen,' some idea of the physique of the paupers who were thus set to work, and he will not be surprised to learn that the out-turn of their labours at first was small. In a letter written about this time the following description occurs:—'As to the 5,000 who are now at work there, though they have hardly been employed for more than a fortnight, the change in their appearance is already remarkable. None of them were able-bodied, and many were in an advanced stage of emaciation. The professional officers said of many of them, "Call that fellow a labourer? why he can't lift a pick-axe." Well, they could not lift a heavy pick-axe, so we gave them a light one; they were treated considerately and kindly; they were not tasked above their strength, and now almost the whole of that gang are able-bodied labourers, doing nearly a full day's work, cheerful, healthy, and contented. Had they continued as they were, recipients of gratuitous relief, fully half of them were marked for death.'

"But once they were set to wholesome, adequate, disciplined work in the open air, and paid a sufficient wage, their improvement—unless famine-diarrhœa had set in—was rapid and manifest. One of the earliest gangs was carefully examined by myself in January, 1878. I do not mean to say that every person in the gang had been one of those taken from the kitchen and set to work in September, for some had died and some had left, and new labourers had taken their place, but the gang itself was the same and had remained from the first under the same officer, and the majority of the people who composed it had been in it from the beginning, and they were then as fine and strong a body of labourers as could be met with anywhere. Where one policy resulted in bringing people into the state in which they were found in September, and the other was instrumental in rescuing thousands from the point of death and restoring them to the condition they had attained in January, there is little room for argument about the merits of the two."

FOOD SUPPLY.

Arguments against Government Intervention.—The question of the direct intervention of Government with the object of aiding or supplementing the action of private trade in importing food into famine tracts was discussed by the Famine Commission, and the principles then laid down were, at the time, fully accepted by public opinion. They have been to some extent controverted when the extent of the present famine began to be realised; but they have again been asserted and enforced by the Government of India and the Secretary of State in England. The first step in the argument was to show that, on a very moderate calculation, there is ordinarily raised a surplus of about 5,000,000 tons of food grains in excess of the usual rate of consumption; and though the population of British India has since then increased by about 33,000,000 people, the area cultivated has advanced in a considerable proportion, while improvements in agriculture and in irrigation have still further raised the out-turn so that it is reasonable to hold that the average surplus production still stands at about the same figure. In the Famine Blue-book published last January, I find a careful calculation made by the Agricultural Director of the Punjab shewing a larger surplus of food grain in that province than what the Famine Commission estimated twenty years ago. It follows, therefore, that if drought diminishes the food crop by 5,000,000 tons, there will still be a sufficient supply of food for the entire country. It was estimated that, in 1877, Burma was able to export a surplus of 800,000 tons, whilst in the present year we know that it can export 1,500,000 tons. Then we have to consider the question of food stocks, and, no doubt, there is a general belief that the habit of storing food in pits for future use has decreased on the part of agriculturists, and possibly also on the part of merchants, who are tempted by the facilities offered by railways to send it away for sale to any place where a more advantageous price can be obtained, trusting to the same means for recouping themselves whenever home prices require it. To this may be attributed the extremely high level which prices reached as soon as the deficiency in last year's rain declared itself, and which was maintained steadily for some time, though it has fallen in most places of late. As many as seventy-eight districts returned the selling price of the commonest food grain at less than 10 seers per rupee. But this high level, alarming as it is, exercises a beneficial influence by reducing the general average rate of consumption, and thus by widening the area attenuates the severity of the distress and adds to the surplus available for the parts most denuded of food. High as the prices were, they are not quite equal to what is an ordinary price in England, and we have seen the curious result that wheat brought from California has been carried away from Calcutta because it could not be sold in Indi at a remunerative price. Then on the credi side must be placed the great development o railways, which has already been dwelt o and illustrated, and the increased activity c commerce which makes it possible to impo food from distant countries such as California Russia, or Australia, at short notice, if price rise to a point which make it profitabl Careful inquiries instituted by every Loca Government have led the officials to the con clusion that there is a sufficient supply of foo in the country for present needs, and that if the spring harvest which is now about to be reaped turns out favourably, the crop will carry the population on till the next autumn harvest comes in. On the whole, then, my judgment is, though I submit it with many reservations, that if the stock of food in the country was somewhat less than in 1877, the means of importing and transporting food grains are so much more ample and more efficient that we are on the whole in a better position as regards the supply of food to the distressed area than we were in that year. The facilities and activity of trade are such that the motive of self-interest is sufficient to set its machinery in action as soon as a deficiency in the supply of food is found to exist. Government cannot successfully compete with private trade in such a task; as Lord Northbrook tersely said, although it can do more than any one trader, it cannot do as much as all traders; but there is one thing which it can do, and certainly will do, f it interferes in the business, and that is t will drive traders away and discourage hem from intermeddling in the trade, if hey have to act subject to conditions which hey cannot foresee or control. This was made very evident in the Bihar famine of 1874, where Government declared its intention to arrange for importing a supply of food, not for the population at large but only for the people collected on its own relief works. It soon found hat under these circumstances traders would not enter into competition with it, not being secure of a market or of prices, and Government was forced to extend its operations so as cover the whole of the local deficiency. With what success and at what expense it did this, s universally known. The success was due to he fact that the area was comparatively small: had it been anything corresponding to the area of 1877 or 1897 success would have been mpossible and the expense would have been beyond calculation. On these grounds, when he Lieutenant-Governor of Bengal proposed scheme for assisting traders to import grain by ffering advances of money the Government of ndia negatived it, holding that it could not be arried out without involving interference with ordinary private trade, or at any rate without earing the appearance and creating the pprehension of such interference, and the ppearance in such a case would be almost worse then the reality, since while producing ll its evils it would carry with it none of its dvantages."

Exceptional Cases.—At the same time the Famine Commission recognised the existence of exceptional cases in which intervention of Government might be necessary, the chief instance being when masses of labourers are collected on relief works in out of the way places where no arrangements for the sale of food exist. In all such cases the Famine Code provides for securing a contractor who will bring the grain and sell it on the spot. If such arrangements cannot be made, the Government officers must transport and distribute the grain themselves. Similar difficulties, it was thought, may arise in districts where communications are defective, or where local traders show no energy or do not exist; there it held that Government might rightly intervene "and its action in importing grain from a distance (that is, from a large market in the country, not from abroad) might have a beneficial effect, both by proving to the local traders that such an undertaking is practicable and profitable, and by removing the panic which may have led the agriculturists to close their grain pits." But the fact is that within the last twenty years the extension and multiplication of railways and roads, and the growth of capital and competition among the trading community, have organised and opened out the country in such a way that it is extremely doubtful if any such tracts now exist.

Importation of Grain unsuitable work for Government Officers.—I might add one more argument against the thesis that Government should intermeddle with the importation of grain, and that is that its officers have their hands full, and more than full in carrying out the operations of direct relief, and that it would be in the highest degree unwise, except under dire necessity and in the last resort, to lay upon them this additional strain. The work of directing relief operations is work of a nature similar to what they are accustomed to, requiring the gift of organisation, humane sympathy, the sense of justice, the habit of command. The work of buying, importing, transporting, storing, and distributing grain lies altogether outside of their training. They cannot do it well, and those who are employed in doing it ill will be so many deducted from the ranks of those who are doing their proper work efficiently and well.

GOVERNMENT LOANS.

The next recommendations of the Famine Commission related to reforms in the system of granting loans of Government money to facilitate land improvement. The chief points taken were: that time should be allowed for completion of the improvements before the repayment of the loan began; that the period for repayment of the loan should be enlarged, and the instalments fixed so as to pay off capital and interest together in the given number of years; and that, in addition to the objects for which loans were then granted (wells or tanks, drainage works, and works of reclamation), it should be lawful to advance money to help landowners to pay off debts, to buy bullocks or seed grain, and to make embankments and water-courses. Such improvements should not be made the ground for increased settlements, and the right of the cultivating tenant to make them without the necessity for obtaining his landlord's sanction should be affirmed. All these reforms have been carried out, and provision for the two latter objects has been made in the legislation which has been dealt with under the head of tenures, and in the special Act of 1883. The result has been to increase the readiness of the landed classes to apply for such advances. In the year 1877-8, even in the height of famine, when such advances were likely to be especially welcomed, only 4½ lakhs of rupees were granted as loans to all India. Since 1881, the figures have been as follows:—

	Rx.
1881-2	48,000
1882-3	71,300
1883-4	97,860
1884-5	103,995
1885-6	92,410
1886-7	82,510
1887-8	91,020
1888-9	115,410
1889-90	167,880
1890-1	206,380

In Madras alone, in 1891-2, nearly 17 lakhs were lent, and in the North-West Provinces, in 1896, 18 lakhs of rupees were advanced as loans to agriculturists.

Indirect Relief Tenures.

Among the measures proposed for indirect relief, that is for organising the community in such a way as to prepare and strengthen it against the approach of famine, the Commission dwelt forcibly on the introduction of legal provisions for the protection of the rights of the cultivators. It is only under such tenures, they wrote, "as convey permanency of holding, protection from arbitrary enhancement of rent, and security for improvements, that we can expect to see property accumulated, credit grow up, and improvements effected in the system of cultivation." Their recommendations may be summarised thus:—

Enlargement and strengthening of occupancy right.

Alteration in the law as to enhancement of rent, including a reversion to the old principle of fixing rents for the term for which the land revenue is settled, or for a long term when the land revenue is permanent.

Alteration in the presumption as to continuous occupation, so that all tenants who have resided and have cultivated land for 12 years and upwards in the village should be entitled to occupancy right in their land, the onus of proving to the contrary being laid on the landlord.

Limitation of the power of ejectment for arrears of rent in the case of both occupancy tenants and tenants at will.

Right of the tenant to sell his interest in the land, whenever a custom to that effect exists.

Restriction of the power of sub-letting.

Conferment on the tenant-at-will of the power to purchase occupancy rights.

Compensation for improvements, in case of ejectment.

Introduction of a survey and record of rights in Bengal.

Prevention of abuses connected with the payment of rent in kind, by taking a share of the produce.

These views were accepted by the Government of India, and there has been much activity on the part of the local legislatures in carrying them out.

Tenure Reforms in Bengal.—In Bengal, which was the province where the greatest complaints had arisen, the Tenancy Act of 1885 introduced extensive and most beneficial reforms. It created the tenure now known as that of a "settled ryot," giving him the same security in his holding as that which he enjoyed under the old customary law; it provided for the authoritative record of price lists; and it contained valuable provisions for the determination of the incidents of a tenancy, for settling disputes between a landlord and his body of tenants about the rent roll, and for framing a record of rights and settlement of rents. Bengal is the only part of India in which no field survey or record of the rights of tenants had at that time been effected, and my predecessor, Sir Steuart Bayley, took advantage of the provisions of the new law to institute an experimental survey in a small part of Bihar, which was carried out with great success, though the lack of funds prevented its further extension at the time. I had the good fortune in 1891 to be able to persuade the Government of India and the Home Government to provide the necessary grant of money, and to sanction the carrying on of the survey in the four districts of North Bihar. These were selected as the tract where the greatest difficulties existed, the population being extremely dense, and the tenants ground down by keen mutual competition for land and by the exactions of the powerful landowners, and they are precisely the four districts in Bengal which are now suffering severely from famine. I am glad to be able to add that though the survey-settlement was at first looked on with great disfavour, and strongly opposed by the land-holding interests, before I left India the hostility to it had for the most part passed away, and the benefits accruing from it to all parties were widely realised. One of its results, and perhaps the most important, was to show that the persons enjoying the privileges of settled ryots, as defined by the Tenancy Act, amounted to about 90 per cent. of the whole number of cultivating tenants, and the *régime* of illegal distraint, illegal exaction and illegal ejectment, denounced by a former Lieuenant-Governor, Sir Ashley Eden, has passed away.

In Oudh and the North-West Provinces.—In Oudh, where the nature of the settlement nade with the Talukdars after the Mutiny imorted special political difficulties into any ttempt to curtail their power and privileges, an ct has been passed with their consent giving large amount of protection to tenants against nhancement and ejectment. In the North-Vest Provinces, similar amendments have een introduced into the statute.book, though he status of a settled ryot has not been coneded to the occupancy tenant, nor is his rent xed for the same period as that for which the nd revenue is settled.

In the Punjab.—In the Punjab a liberal easure of amendment was passed in 1887, arrying out most of the Famine Commision's recommendations, but for historical nd economical reasons the status of the nant is not so strong in the Punjab as elsehere, the proprietors being for the most part ot powerful single landholders but village mmunities, who require and claim, as eir numbers increase, the right of expanon over the village lands, and object to any fixity of adverse tenure being given to the tenants who are not members of their community.

Central Provinces.—In the Central Provinces the tenancy law has been twice amended since 1880, and this is the only province in which the recommendation to fix rents for the term of the settlement has been followed. The local authorities did not assent to the Bengal principle of granting to resident cultivators the status of a settled ryot, but tried the experiment of allowing the occupancy tenant to purchase that status. The experiment failed, and I believe it is proposed now to introduce the Bengal rule. In all these provinces except Bengal the principle of keeping up a continuous record, by which changes of possession and occupation are recorded by the village accountant on the village maps and papers, is fully established, and this of itself is a great safeguard against any illegal oppression of the tenant.

Bombay, Madras.—In Bombay and Madras, where the ryotwari system exists, that is, where the Government deals directly with the occupying tenants and receives the land revenue from them without the intervention of any superior landholder, the dangers and difficulties prevailing in Northern India do not exist, and the only recommendations made by the Famine Commission related to the protection of sub-tenants and the restriction of sub-letting in Bombay, and to the case of the ryots holding under the great zemindars in Madras. The Bombay Government held that the number of subtenants was too small, and the practice of sub-letting too rare, to require any legislative measures to be taken. In Madras, where the zemindars pay a land revenue which is fixed in perpetuity, and is seldom more than a mere quit rent, the Government has provided for the appointment of village officers and is still engaged in considering an Act providing for the field survey and the maintenance of a record of rights, and the protection of the rights of ryots, in the zemindari tracts, which occupy nearly a third of the province.

It will thus be seen that since the Famine Commission reported, successful efforts have been made in almost every part of India to place the great body of tenants in such a position of security as must increase their self-reliance, their power of accumulating capital, and their credit, and must materially assist them in resisting the disasters inflicted by drought and the loss of their crops.

ELASTICITY OF THE LAND REVENUE.

The next point discussed was the system of collecting the Land Revenue—and suggestions were made for introducing greater elasticity into the system, providing (1) for postponement or remission of the demand in years of scarcity, and (2) for imposing a fluctuating instead of a fixed assessment in certain exceptional cases. The former of these two principles has been extensively carried out, the yearly average of the suspensions or remissions of the land revenue having amounted to about 23½ lahks of rupees since 1881, and we know that recourse has been largely had to this form of relief in the present season; in the North-West Provinces alone, eleven lahks of rupees were suspended in 1896. A recent telegram from the Government of India has estimated the amount of land revenue remitted or suspended in all India at 230 lakhs of rupees. In most provinces also legal enactments have been passed extending to the tenants a right to the same leniency in payment of their rents as is shown to land-holders. In discussing the second principle, it was held that though the rigidity of a fixed demand would sometimes press severely on the agricultural classes, yet the advantages of certainty ought not lightly to be thrown away. They consist in the provision of a strong incentive to thrift and self-reliance by encouraging the habit of laying by in a good year to meet the possible losses of a bad year. "Nothing could be more injurious to the character of the landed classes of India than that a man should not know at the beginning of a year what he will have to pay to Government during its course, or should be led to believe that by collusion with a native official, or by working on the sympathies or ignorance of the English officials, he may obtain a decrease in the year's demand." These considerations have had due weight, and the system of annually fluctuating assessments has only been extended to some dry tracts in Ajmir, and to the riparian villages in the Punjab, where the crops depend entirely on inundation from the rivers, which may fail or may prove excessive, or may take place too soon or too late for agricultural operations. In other parts the idea has been dropped in view of the dislike of the people themselves to the system, and of the difficulty of effecting fluctuating assessments on any sound and uniform basis.

THE AGRICULTURAL DEPARTMENT.

The next great class of recommendations made by the Famine Commission related to agricultural improvements and the creation of an Agricultural Department. They pointed to such measures as the introduction of new staples, the better cultivation of special crops and of the ordinary staples, the establishment of experimental farms, the improvement of agricultural implements, and of the methods of cattle breeding; and they remarked that hitherto the defect in the efforts of Government had "consisted in the failure to recognise the fact that in order to improve Indian agriculture it is necessary to become thoroughly acquainted with it, and to learn what adaptation is needed to suit modern and more scientific methods and maxims to the Indian staples, soils, and climate. In some cases men have been sent out to teach or practise agriculture who were not agriculturists; and too often when they were beginning to learn the elements of the problem before them, the Government has thrown up the attempt as expensive and a failure." Accordingly they advocated the creation of an Agricultural Department in each province, to consist of two classes of officers; (1) trained experts, at the rate of two or three to a province, to be appointed in England, possessing superior technical and scientific knowledge of practical agriculture, agricultural chemistry and botany; and (2) a body of public officers selected from the ordinary executive service, with sufficient training in scientific agriculture to see that the knowledge of the special experts is applied in the best way, to interpret improvements to the people, and to stimulate popular sympathy and interest in the efforts made to introduce them. These recommendations have not been adopted in all respects, but the main proposal was heartily accepted by the Indian and Home Governments, and the officer elected to be head of the department and secretary to the Government of India with more or less peripatetic functions, was Sir Edward Buck. It is to this fortunate selection of a man who has given his whole time and his great ability to the perfection of the instrument placed in his hands, with rare devotion and complete abandonment of other openings for his advancement, that the progress hitherto made in the solution of the difficult and intricate problem involved is mainly due.

The Secretary of State in 1881, in sanctioning the creation of the new department, laid down its objects as follows:—First, Agricultural Enquiry, more complete and systematic, ascertaining and rendering available the statistics of vital agricultural and economic facts for every part of India; secondly, Agricultural Improvement, with the view of increasing the food supply and general resources of the people; and, thirdly, Famine Relief, *i.e.*, its better and prompter organisation whenever the actual approach of famine may be indicated by the statistical information. With the last head I have dealt already; it remains to describe as succinctly as possible what has been done under the two other heads.

Work done by the Agricultural Department.—The first step was to take in hand the improvement of the agricultural records annually prepared by the village accountant, aiming at such a degree of accuracy that they can be relied on to provide tolerably true statistics of crop, area, rents, and produce, and can be utilised in keeping up a continuing record of changes in the papers on which the amount of the land revenue is based. The measures taken to this end were:—(1) The organisation of establishments for collecting agricultural facts and statistics; (2) the organisation of a system for supervising and training the establishments; (3) the organisation of a system of land records to be maintained by these establishments. This task involved an immense amount of attention and labour, but it has been so far carried out, at least in the Punjab, the North-West Provinces, and the Central Provinces, that it was calculated by the Finance Commission in 1887 that Sir E. Buck had so lowered the cost of settlement, that he had saved the State no less than two crores of rupees. The next step was to utilise these records in carrying out a district analysis, or special enquiry into the agricultural conditions of each district, with a view to discover the extent to which these conditions fell short of a satisfactory standard, and what remedies could be suggested. The character of soils and the manures suited to them, the improvement of seed grain, and the utilisation of liquid manure which is now wasted; the diseases of cattle and plants, and the means by which they can be prevented, minimised, or cured; the extension of irrigation; the improvement of fuel and fodder supplies; the reclamation of waste lands; the improvement of old and the introduction of new staples and agricultural implements; possible reforms in the methods of cultivation; all such subjects as these formed part of the programme of enquiry. In order to facilitate such scientific examinations by experts, the Geological Survey and meteorological branches were brought into direct relations with the Agricultural Department; three new officers were attached to the Indian Museum for agricultural entomology and the survey of art industries and economic products; a civil veterinary department, which includes an expert engaged in bacteriological research, was created, and two experts in agricultural chemistry were appointed. In 1889, Dr. Voelcker was sent out by the Secretary of State "to advise on the best course to be adopted in order to apply the teachings of agricultural chemistry, and to effect improvements in Indian agriculture." His report, which is a valuable repertory of useful information, contains 66 specific recommendations which turn chiefly on the heads of agricultural enquiry and maintenance of accurate records above referred to. He dealt especially on the necessity of scientific advice, and of central direction for the preservation of continuity, and urged that general agricultural inquiry could not be conducted without men who had made agricultural chemistry a special study; and two experts selected by him have been deputed to India for this purpose. In all these matters much activity has been shown, and great advance has been made, one of the results of which is to be seen in the instructive and elaborate reports submitted by all the Local Governments on the condition of the country after the recent failure of rain, and on the prospects of approaching distress; reports which show that the district officers now possess a grasp of the subject, and an intimate knowledge of the facts such as certainly did not exist in 1876-7, at the inception of the last great famine. Much light has also been thrown on agricultural practices, and it has been shown that notwithstanding the hereditary experience of the Indian cultivator, and the special knowledge which he possesses of methods and appliances suited to the locality in which his crops are raised, many defects do exist in the agricultural system of almost every district, which, if they cannot be altogether removed, can at best be considerably modified and lessened. The problem of reclaiming lands rendered unculturable by an excess of salts, many thousand square miles of which exist, has been grappled with and apparently solved, and a profitable dairy farm has been established on a tract of this class. Land which was a mere network of ravines, affording grazing of the poorest description, has been reclaimed and turned into a valuable fodder reserve. The only point as to which the Famine Commission's recommendations have not been carried out has been the training of young civilians in practical agriculture, and the modification of the competitive examinations by which they are selected, so as to give greater importance to the knowledge of natural and physical sciences. On the other hand, the Government of India has drawn up a scheme under which a strong and efficient staff of agricultural experts shall be provided in each province, and has decided that until natives sufficiently trained and qualified come forward, the staff shall include at least one European expert. It has also lately declared its intention to add some technical and practical training in agriculture to the curriculum of the rural elementary schools.

FORESTS.

Another topic adverted to was the preservation and enlargement of the forest area, not only as a valuable property to be administered for the better production of timber and grass, but also to protect the hill slopes from denudation, to store up the moisture of the subsoil and maintain the supply of water in wells, and to be a reserve which can be drawn upon for the provision of fodder and grazing for cattle in times of drought. At the time the Report was drawn up there were 60,000 square miles of forest in India more or less controlled by the Government, only 24,000 of which were classed as "reserved" and actually protected by special legislation from all injury and devoted strictly to forest uses. At the present time we have about 120,000 square miles of forest administered by Government, of which 67,000 square miles are strictly "reserved." This extension has been made under the operation of the Forest Act of 1878, and similar local laws based upon it, and the benefits arising from these measures will be shown in the preservation of cattle life during the present famine. It has already been announced that the forests in the Central Provinces have been thrown open to cattle for grazing, and we may confidently hope that much of the cattle mortality which always follows a drought will thus be averted.

EMIGRATION.

The gravity of the problem of the vast and rapidly-increasing population pressing closely on the food supply and constantly tending to diminish the margin left against a scarcity, was deeply felt by the Famine Commission, as it has been by all who have meditated on the future development of the country. The remedies they indicated were of two kinds: first, the increase of the food supply by extension of cultivation and of irrigation, and by better methods of agriculture; second, the diversion of the people to other countries, and to other occupations than that of agriculture. They pointed to emigration as an outlet for the surplus population, whether in the direction of foreign countries or of unoccupied tracts in India, and while they realised the difficulty of State interference in such a movement, they thought it not impossible that a scheme of migration might be devised with scientific care to meet the mental and moral idiosyncracies of the people. In this particular direction no success has been obtained, but much has been done to facilitate migration both to the Colonies and to Burma and Assam. Colonial emigration, which averaged about 9,000 persons a year between 1876 and 1880, now has risen to about 17,000 a year. Assam annually receives about 50,000 persons, most of whom go to labour in the tea gardens and afterwards settle down as resident cultivators. The emigration to Ceylon, the Straits, and Burma amounts to about 200,000 a year, but most of them return after a time and few settle down permanently. The successful colonisation of about 600,000 acres of waste land on the newly opened canals by settlers from the thickly-populated districts of the Punjab has already been referred to.

DIVERSITY OF OCCUPATIONS.

It was admitted that little could be done by the direct action of the State towards diverting the people from exclusive devotion to agriculture; all that Government has been able to do has been to supply information with the view of developing the industries of the country. A special officer has been appointed to study the economic products and watch opportunities of developing trade; a compilation has been issued containing complete information on these products up to date; special industries have been advertised at international and local exhibitions; the economic character of Indian museums has been developed; full assistance has been given to the practical side of the Imperial Institute in London; the geological survey of the country has been utilised for practical results; mining enterprise has been encouraged, and information on arts and industries has been collected. But any development of this character must come from the growth of a popular inclination to leave the ancestral paths and adopt new kinds of industry. The Famine Commission pointed to the cultivation and manufacture of tea, tobacco, and indigo, the employment offered on the railways, and in cotton, wool, and jute mills, the openings for sugar refineries and tanneries, the manufacture of silk, paper, glass, pottery, soaps, oils, and candles, as examples of industries which might be introduced or largely developed in India and might thus draw off a portion of the population from the land. Some advance has been visibly made in this direction during the last twenty years, and I may be permitted to quote an extract from a farewell speech I made to the commercial community of Calcutta in 1894 on this subject. After quoting Tennyson's lines:—

> "Every minute dies a man,
> Every minute one is born."

and saying that in Bengal every minute seven persons die and eight are born, I went on as follows:—

> "The tea-gardens of Assam draw off about 50,000 emigrants a year, and during the last five years the gardens of the Duars and Darjeeling have increased their population at the rate of about 6,000 a year. The colonies take off about 10,000 a year; the factories of Bengal employ, according to our estimate, 85,000 hands, and the annual increase during the last 5 years has been about 9,000. The coal mines during the same period have absorbed an increase of about 10,000 hands a year, and their proper development requires an annual addition of at least double that number. Add to these the spread of employment in the indigo factories, the railways, the post and telegraphic department, and it is safe to assert that against the annual growth of half a million of people in Bengal, we can put a figure of about 100,000 as representing the number of persons (mostly adult-males) who are every year drawn off the land and enabled to find a livelihood by the diversity of occupations which Calcutta trade and English capital create. So mightily does the community represented here to-night co-operate with the Government in meeting the greatest economical danger to which the Indian empire is subject."

COMPARISON OF PRESENT WITH PRECEDING FAMINES.

Presumptions Drawn from the Past.—I turn now from a consideration of the measures proposed and carried out in preparation for the present famine to a comparison of its severity with that of its predecessors, and an examination of the actual effect which our protective and preventive measures have had, as far as our information goes. After a comprehensive survey of the areas and population affected on previous occasions, the Commissioners came to the conclusion that the famine of 1876-8 was the severest hitherto known, and they thought it might be assumed that it was not likely to be exceeded in the future, either in the extent of country injured or in the degree of relief that will be required. That famine visited, in two consecutive years, 257,000 square miles inhabited by 58,000,000 people. It was acute in 105,000 square miles with a population of 19,000,000; it was severe in an area of 102,000 square miles with a population of 19,000,000; and it was slight in an area of 50,000 square miles with a population of 10,000,000. In the area slightly attacked little or no relief was required, and this part of the tract was dismissed from further consideration; but relief was afforded to 780,000 persons, or 5 per cent. of the population of the more afflicted area in Madras for twenty-two consecutive months, and in Bombay to 320,000 persons, or 3½ per cent., for thirteen months. The maximum number relieved during the worst month was about 2,250,000 in Madras, and 500,000 in Bombay, or from 6 to 15 per cent. of the population severely affected. On this basis it was estimated that the maximum number likely to be in receipt of relief in the worst month was about 15 per cent. and from 7 to 8 per cent. was the average number likely to be requiring relief continuously for the space of a year.

The Secretary of State on the 15th January, 1897, summarised the reports of the present famine received up to that date from India as indicating that an area of 164,000 miles inhabited by 37,000,000 people was visited by famine, while distress was felt by 44,000,000 inhabiting 121,000 square miles. These figures are for British India only, and it was estimated that in the Native States 6,000,000 people were affected by famine. If these figures turn out to be correct, the extent of the present famine will have largely exceeded that of 1876-8. But some of these estimates were framed at an early date before the area sown with winter crops and the prospects of the spring harvest could be fully known; and since then there has been a general copious rainfall, which has somewhat lowered prices, put heart into the agricultural classes, and probably materially contracted the area of severe distress. I hear from the Punjab of "contracts forward" for the wheat now ripening at 13 seers per rupee, which is not very much in excess of the ordinary price. The Government of India's telegram received in the middle of February calculated the "distressed" area (excluding Burma, which has an isolated and purely local trouble, with which that prosperous province can very well deal) at 138,000 square miles with a population of 38,500,000, while the area more or less slightly "affected" was stated at 24,000 square miles, inhabited by 13,500,000. These figures if added together give a total area considerably less than that of 1876-8 and a population less by 10 per cent. The numbers on relief already exceed three millions, and have mounted up rapidly since December, though last week's return shows a distinct check in the progress; they already exceed the maxima for Bombay and Madras in 1877, which amounted to two and three-quarters of a million, but relief is given now on a much more liberal scale than then, and in any year relief offered liberally during the months when little or no labour in the fields is required would attract enormous crowds. It must not be forgotten that in the comparatively small famine of 1874 in Bihar there were at one time two millions of people in receipt of relief, and 10 per cent. of the population remained in receipt of it for nine months. A similar ratio now, if struck on the whole affected population, would give a far more formidable total.

On the whole I think that a reasonable hope may be entertained that the extent of the calamity may turn out to be somewhat less than was at first anticipated, partly because the very extent of the information obtained by the present improved organisation tends to bring to light every defect in out-turn however small, and partly because the winter rains have been so favourable that the crop now coming to maturity has employed more field labour than was expected and will when reaped materially lighten the pressure for food. I do not wish to be thought in any way to criticise the estimates of the Local Governments, which appear to me to have been far more careful, precise, and detailed than any that were submitted in 1876-7, but it seemed to me that it might be advantageous to approach the question from a different point, and to test the severity of the distress by an examination of the number of people actually on relief according to the latest returns. I have drawn up a statement (*see* pp. 367, 368) showing the area and population of each district, the number reported to be receiving relief of all kinds, and the percentage this number bears to the population, and I have coloured a map with four colours so as to show those parts where the population on relief are less than 1 per cent., from 1 to 5 per cent., from 5 to 10 per cent., and over 10 per cent. According to this classification, the following results may be deduced from the latest detailed returns, which give the figures for the first half of February :—

Classification by Number of Persons on Relief.	No. of Districts.	Area.	Population.*	No. of Persons on Relief in the first half of Feb.*
One per cent. and under	26	105,021	29,300	157
From 1 to 5 per cent. ...	27	92,270	24,546	648
From 5 to 10 per cent....	10	30,747	10,743	814
Over 10 per cent.... ...	9	29,002	6,918	968
Total	72	257,040	71,507	2,587

* Three o's omitted.

I think it may be safely held that the districts in which, up to the middle of February, less than 1 per cent. of the population required relief are, at any rate for the most part, very slightly affected, and probably they are suffering not so much from immediate loss of crops as from the high range of prices which prevails all over India, and which entails privation on all who live by wages and have to buy food, whether the crops in their neighbourhood are good or not. This part of the country lies within the penumbra, not within the path of the eclipse; and its omission would bring down the area actually visited by famine to 150,000 square miles, with a population of 40,500,000; a smaller area, but a slightly larger population than that in which the 1876-8 famine was acute or severe. As to the classification of the different parts of this area it is too early to venture on any definite prediction. It may safely be said that in the districts where there are more than 10 per cent. now on relief, the famine is acute; this area comprises the Jalaun, Banda, Hamirpur, Allahabad, and Hardoi districts in the North-West Provinces, Jabalpur, Dumoh, and probably Saugur in the Central Provinces, and Sholapur and Bijapur in Bombay. It may be feared that most of the tracts where there are now more than 5 per cent. of the population on relief will, as time goes on, and food stocks decrease, fall into the same category; these comprise four districts in the North-West Provinces (Jhansi in Bundelkhand, Cawnpur, Rai Bareilly, and Lucknow), Champaran and Darbhanga in Bengal, Narsinghpur and Hoshangabad in the Central

Provinces, Ahmednagar in Bombay. The twenty-seven districts in which the relief figures exceed 1 per cent., and fall below 5 per cent. of the population, are probably in a state of suspense; they may tide over their difficulties, especially if helped by a good spring harvest, or they may develop a state of severe distress. But it seems to me that the whole of the Punjab may be struck off the famine area, so may the Rohilkhand division in the North-West Provinces, and so may all Madras, with the possible exception of Bellany. On the other hand there is probably severe famine in the native states of Central India, between the Jumna and Nerbudda, and in a less extent in Rajputana and in parts of Hyderabad, but as to these we have as yet no accurate information. So far, however, as our present information goes, there seems to me nothing to indicate that the famine is likely to be so tremendous as to be beyond the power of the Government of India to deal with it. Relief is evidently being given in most parts with the utmost liberality, and this is especially the case in the North-West Provinces, where gratuitous relief is being given to distressed people in their homes to an extent never known before, except in Bihar in 1874.

Mortality Inevitable.—But however liberal and effective the relief measures may be, it is idle to entertain the hope that it is possible to ward off a great and widespread mortality. The Famine Commission fully recognised this when they wrote that "it is impossible for the State entirely to counteract the effect of high prices, the cessation of wages, the disturbance of the ordinary routine of life, the general results of shortened food supply to millions of people." Hunger, as a rule, does not cause death directly, but various diseases fasten on the people arising from long-continued innutrition, eating roots and leaves and jungle produce and unwholesome food, ravenously devouring an offered meal one day and going without it the next, aimless wandering and exposure. These diseases gradually weaken and carry them off; cholera generally breaks out among them; and the mortuary returns are raised to an inordinate pitch in this indirect way, not by deaths which can be positively classed as due directly to starvation. In comparatively early days, the Government declared that it held its officers personally responsible that no preventable death from starvation should occur. Now it has grown wiser, and only holds them responsible for carrying out such measures that no death need occur if the people will avail themselves of the relief offered them. The great difficulty has always been that so many people are unwilling to accept relief in the manner and on the terms in which it is offered, and the propriety of enforcing compulsory relief has at times presented itself before every famine administrator. The Bombay Government in 1877-8 sought for legislative power to make the acceptance of relief compulsory, and the Famine Commission thought such a power would be valuable if used with discretion and confined within narrow limits; but no such laws have yet been enacted, though the power has at times been assumed as necessary by many humane officers. It is intermittent and indiscriminate private charity which, more than anything else, encourages the fatal habit of wandering, which is the chief cause of mortality. Native charity "does not tend to organisation or co-operation among those who bestow it; it consists too often of giving a small dole to numerous applicants rather than in providing completely for the wants of a few. When famine has once set in with severity, such charity may become a serious evil. The rumour that doles of food or money are liberally given in any town penetrates into the country, unsettles men's minds, and makes them disinclined to honest exertion. The want of organisation results in the strongest paupers getting more than the weak, who need help most and sometimes in the latter being altogether deprived of their food. This uncertain unequal distribution of food often leads to disease and death."

Sphere of Charitable Relief.—I am led by these remarks on the abuses to which native private charity is liable, to make a few concluding observations on the great and munificent collection of charitable relief money which is now being made at the Mansion-house. Many people have remarked that they would give more amply if they knew how the money was to be expended, and if they could realise where the dividing line is drawn between the sphere of Government activity and the sphere of charitable relief. The Secretary of State did indeed point out clearly, in addressing the Lord Mayor, to what objects charitable relief will be devoted, but it may serve a useful purpose if I give some definite statement as to how the money collected in a similar way was utilised in 1877. The collections then were about £500,000 by the Lord Mayor, and £200,000 in Lancashire, Scotland, and elsewhere. One quarter of the total sum remitted from England to Madras, or about 16½ lakhs of rupees, was allotted by the Madras Committee to Mysore and was expended under my orders as Famine Commissioner. Then as now a portion was set aside for hospital comforts for the sick, additional food for the aged, clothes for the half-naked paupers, and for the support of orphanages. But the main use to which the money was put was restoring the people to their ante-famine condition, setting them up again with the implements of their trade and a little capital to work on, and thus enabling them to support themselves. The principal class to be helped were cultivators who had lost their bullocks through death or robbery, and who, unless they could re-purchase them, could never hope to resume their hereditary position, but must sink to be field-labourers and common coolies for the rest of their lives. Here is an extract from a report sent me by one of the relief officers. "To-day in one village there were only two people who had anything at all growing in their fields; formerly there were thirty families of ryots and three of pariahs, now seventeen houses were empty in the parent village; in the outlying hamlet there are weeds and briars, but no human beings. One woman had lost a hundred sheep, all stolen; six cattle gone, part sold by herself; her mother-in-law and two children to keep; not a blade of grass on her land, and everything but some earthen pots sold. I gave her ten rupees for seed and food grain." Of another place a relief officer wrote: "I was not prepared to see such misery, such utter ruin and desolation. The English money has not come too soon. I only wish those who sent it could see for themselves how much it is required, and what a blessing it is. In the village I visited to-day there were but ten families, or rather remnants of families, out of twenty-seven formerly. I will describe one case which impressed me much, and it is really only one of many. With us, if only one member of a family dies, it is a matter of great mourning and grief. In the case I describe there had been seven relatives with their wives and families, numbering in all twenty-seven, all living in one large enclosure. Of these, seventeen had died, the rest dispersed, and only one man with his daughter and a brother left. This man had formerly possessed twelve acres of land, four bullocks, seventy sheep, and had been very well off. He now possessed nothing but a rag round his loins. I gave this poor wretch 20 rupees for a pair of bullocks, and 5 rupees to live on for the present." Similar use was made of the money in the town of Bangalore for the relief of artisans. The town was divided into beats, which were parcelled out to officers. One of my reports states:—"In beat so and so I visited thirty-four houses and found sixty-three looms at work, which supported 211 persons of all ages; 486 rupees had been expended. In another beat I saw fifty-one houses; 592 rupees had been expended and got to work ninety-five looms, which when I first visited the beat, did not exist." Besides the weavers, the market place began to be filled by women selling vegetables, whose stock-in-trade had been purchased by Mansion-house Funds. Various small shops were set up, and the establishment of many small trades gave evidence of the success of the operations. "The silent houses resounded again with the sound of the shuttle and the spinning-wheel; and the dreary and deserted look of the streets in which manufactures had stopped and shops had been closed, soon passed away. I am quite satisfied that the donors of the Mansion-house Funds would be contented if they could have seen the effect of the distribution of their money." I will give one more extract from a letter of my own written at this time:—"I believe I shall never forget the feelings that came over me on inspecting a village which I visited three days ago. It was a village of sixteen houses, and not a roof on one of them. Nine had belonged to ryots of whom only three were left, and one of the three was very sick with fever, added to long innutrition. They had two bullocks between them and had ploughed a little land and reaped a little straw off it. The other seven were low caste. The walls were frayed with rain and partly washed down. All the houses had a few empty pots in them. In a corner or side of each was a little lean-to thatch under which they crouched at night. The two bullocks were tethered in two of the deserted houses. The ruinous aspect of the village gave such an impression of desolation that it was hardly increased by the sight of the people, emaciated, down-hearted, in tatters, covered with itch. It was evening and one could look into all their cooking pots; wild herbs and roots were nine-tenths of the food they had, and there was no grain stored for the morrow to be seen. It was easy to help the ryots. The price of a second bullock to each, a ticket for the sick man promising him the price of a pair when he was well enough to come to head-quarters to ask for it, money for roofs, for seed grain, for food grain, just £6 10s. to spend, and three families were restored from death in life to life. . . . To give bullocks to a ryot who has lost his and must sink to be a field labourer all his days for the want of them; to give a loan to a weaver who is losing the cunning of his right hand in digging on our relief works, to purchase for the stone-cutter his cart, for the blacksmith his tools, for the widow her spinning-wheel, for the goldsmith his implements, for the washerman his donkey, to do this is to restore to the earth her forms of wholesome industry and to knit up again the ravelled bonds of society. It is a work which for the greatness of the labour it requires, and for the magnificence of the effect it produces, may rank with some of the noblest efforts of charity that history records." I may add that most of this relief passed through the hands of officers of high rank and position—much of it through my own. Comparatively little was distributed through subordinate officials, and I never heard a whisper of suspicion that any part of it had been embezzled. This is a sufficient answer to an absurd and injurious suspicion which has lately found utterance and which the Secretary of State for India has effectually answered and exposed.

TABLE SHOWING THE AREA AND POPULATION OF EACH AFFECTED DISTRICT, AND THE NUMBER OF PERSONS IN RECEIPT OF RELIEF IN THE FIRST HALF OF FEBRUARY, 1897.

North-West Provinces.	One per cent. and under.			Over 1 and under 5 per cent.			Five to 10 per cent.			Over 10 per cent.		
	Area.	*Population.	*No. on Relief.	Area.	*Population.	*No. on Relief.	Area.	*Population.	*No. on Relief.	Area.	*Population.	*No. on Relief.
Muttra	—	—	—	1,441	713	16	—	—	—	—	—	—
Agra	—	—	—	1,845	1,004	27	—	—	—	—	—	—
Etawah	—	—	—	1,691	728	17	—	—	—	—	—	—
Etah	1,741	702	5	—	—	—	—	—	—	—	—	—
Azamgarh	2,148	1,729	8	—	—	—	—	—	—	—	—	—
Gorakhpur	4,576	2,994	29	—	—	—	—	—	—	—	—	—
Basti	2,767	1,786	7	—	—	—	—	—	—	—	—	—
Bijnor	1,898	794	4	—	—	—	—	—	—	—	—	—
Moradabad......	2,282	1,179	4	—	—	—	—	—	—	—	—	—
Budaun	2,017	926	2	—	—	—	—	—	—	—	—	—
Bareilly	1,595	1,041	7	—	—	—	—	—	—	—	—	—
Shahjahanpur....	1,744	919	4	—	—	—	—	—	—	—	—	—
Pilibhit	—	—	—	1,372	485	10	—	—	—	—	—	—
Cawnpur........	—	—	—	—	—	—	2,363	1,210	87	—	—	—
Fatehpur	—	—	—	1,633	699	13	—	—	—	—	—	—
Banda	—	—	—	—	—	—	—	—	—	3,060	706	170
Hamirpur	—	—	—	—	—	—	—	—	—	2,289	514	64
Allahabad	—	—	—	—	—	—	—	—	—	2,852	1,549	175
Jhansi	—	—	—	—	—	—	2,588	683	62	—	—	—
Jalaun	—	—	—	—	—	—	—	—	—	1,488	396	96
Mirzapur........	—	—	—	5,223	1,162	29	—	—	—	—	—	—
Benares	1,099	922	4	—	—	—	—	—	—	—	—	—
Jaunpur	—	—	—	1,550	1,265	56	—	—	—	—	—	—
Lucknow	—	—	—	—	—	—	967	774	67	—	—	—
Unao	—	—	—	1,778	954	45	—	—	—	—	—	—
Sitapur	—	—	—	2,255	1,075	51	—	—	—	—	—	—
Rai Bareilly	—	—	—	—	—	—	1,751	1,037	78	—	—	—
Hardoi	—	—	—	—	—	—	—	—	—	2,324	1,113	152
Kheri	2,965	904	4	—	—	—	—	—	—	—	—	—
Fyzabad	—	—	—	1,728	1,217	16	—	—	—	—	—	—
Gonda	2,880	1,459	14	—	—	—	—	—	—	—	—	—
Sultanpur	—	—	—	1,710	1,131	16	—	—	—	—	—	—
Partabgarh......	—	—	—	1,439	911	16	—	—	—	—	—	—
Barabanki	—	—	—	1,740	1,131	42	—	—	—	—	—	—
Total	27,712	15,355	92	25,405	12,475	354	7,669	3,704	294	12,013	4,278	657

* Three o's omitted.

TABLE SHOWING THE AREA AND POPULATION OF EACH AFFECTED DISTRICT, AND THE NUMBER OF PERSONS IN RECEIPT OF RELIEF IN THE FIRST HALF OF FEBRUARY, 1897 *(continued).*

	One per cent. and under.			From 1 to 5 per cent.			From 5 to 10 per cent.			Over 10 per cent.		
	Area.	Population. *	No. on Relief. *	Area.	Population. *	No. on Relief. *	Area.	Population. *	No. on Relief. *	Area.	Population. *	No. on Relief. *
PUNJAB—												
Delhi	1,290	639	4	—	—	—	—	—	—	—	—	—
Karnal	2,440	684	2	—	—	—	—	—	—	—	—	—
Hissar	—	—	—	5,163	773	24	—	—	—	—	—	—
Rohtak	1,797	590	5	—	—	—	—	—	—	—	—	—
Gujarat	—	—	—	2,051	761	34	—	—	—	—	—	—
Total	5,527	1,913	11	7,216	1,537	58	—	—	—	—	—	—
BENGAL—												
Saran	—	—	—	2,653	2,467	32	—	—	—	—	—	—
Champaran	—	—	—	—	—	—	3,531	1,859	116	—	—	—
Muzaffarpur	3,003	2,711	4	—	—	—	—	—	—	—	—	—
Darbhanga	—	—	—	—	—	—	3,335	2,802	214	—	—	—
Total	3,003	2,711	4	2,653	2,467	32	6,866	4,661	330	—	—	—
CENTRAL PROVINCES—												
Nagpur	3,843	758	2	—	—	—	—	—	—	—	—	—
Bhandara	—	—	—	3,968	743	12	—	—	—	—	—	—
Chanda	10,740	698	3	—	—	—	—	—	—	—	—	—
Balaghat	—	—	—	3,139	383	6	—	—	—	—	—	—
Raipur	11,724	1,584	11	—	—	—	—	—	—	—	—	—
Bilaspur	8,341	1,164	9	—	—	—	—	—	—	—	—	—
Jabalpur	—	—	—	—	—	—	—	—	—	3,948	758	99
Saugur	—	—	—	—	—	—	4,007	592	55	—	—	—
Dumoh	—	—	—	—	—	—	—	—	—	2,831	326	36
Seoni	—	—	—	3,198	371	7	—	—	—	—	—	—
Mandla	—	—	—	5,056	339	17	—	—	—	—	—	—
Hoshangabad	—	—	—	—	—	—	4,594	530	36	—	—	—
Narsinghpur	—	—	—	—	—	—	1,916	367	24	—	—	—
Betul	—	—	—	3,824	323	13	—	—	—	—	—	—
Chindwara	—	—	—	4,630	408	8	—	—	—	—	—	—
Nimar	3,357	254	1	—	—	—	—	—	—	—	—	—
Total	38,005	4,458	26	23,818	2,568	63	9,517	1,489	115	6,779	1,084	135
BOMBAY—												
Sholapur	—	—	—	—	—	—	—	—	—	4,542	760	91
Bijapur	—	—	—	—	—	—	—	—	—	5,668	796	85
Belgaum	4,657	1,013	3	—	—	—	—	—	—	—	—	—
Dharwar	4,603	1,051	1	—	—	—	—	—	—	—	—	—
Satara	—	—	—	4,987	1,226	24	—	—	—	—	—	—
Poona	—	—	—	5,369	1,068	25	—	—	—	—	—	—
Ahmednagar	—	—	—	—	—	—	6,695	889	75	—	—	—
Nasik	—	—	—	5,940	844	31	—	—	—	—	—	—
Khandesh	—	—	—	10,907	1,461	28	—	—	—	—	—	—
Total	9,260	2,064	4	27,203	4,599	108	6,695	889	75	10,210	1,556	176
MADRAS—												
Bellary	—	—	—	5,975	900	33	—	—	—	—	—	—
Anantapur	5,275	709	4	—	—	—	—	—	—	—	—	—
Cuddapa	8,722	1,272	9	—	—	—	—	—	—	—	—	—
Karnul	7,514	818	7	—	—	—	—	—	—	—	—	—
Total	21,511	2,799	20	5,975	900	33	—	—	—	—	—	—

* Three o's omitted.

SUMMARY OF PRECEDING TABLES.

	One per cent. and under.				From 1 to 5 per cent.				From 5 to 10 per cent.				Over 10 per cent.			
	No. of districts	Area.	Population. *	No. on relief. *	No. of districts	Area.	Population. *	No. on relief. *	No. of districts	Area.	Population. *	No. on relief. *	No. of districts	Area.	Population. *	No. on relief. *
Punjab	3	5,527	1,913	11	2	7,216	1,537	58	—	—	—	—	—	—	—	—
N.W.P.	12	27,712	15,355	92	13	25,405	12,475	354	4	7,669	3,704	294	5	12,013	4,278	657
Bengal	1	3,003	2,711	4	1	2,653	2,467	32	2	6,866	4,661	330	—	—	—	—
Central Provinces ..	5	38,605	4,458	26	6	23,818	2,568	63	3	9,517	1,489	115	2	6,779	1,084	135
Bombay	2	9,260	2,064	4	4	27,203	4,599	108	1	6,695	889	75	2	10,210	1,556	176
Madras	3	21,511	2,799	20	1	5,975	900	33	—	—	—	—	—	—	—	—
Total	26	105,021	29,300	157	27	92,270	24,546	648	10	30,747	10,743	814	9	29,002	6,918	968

* Three 0's omitted.

I will only say one word in conclusion, to ask your sympathy with and confidence in the officers of the Indian Government, who are now engaged in struggling nobly and I believe successfully in protecting the people against this great calamity. The work is unceasing, the strain tremendous—the Central Provinces has already lost five or six of its ablest officers, who have died or been invalided in the campaign—but those who survive will have the reward of their own conscience and the gratitude of the people, and I trust that the public of England will not be slow to appreciate their merits.

DISCUSSION.

The CHAIRMAN, after congratulating Sir Charles Elliott on the admirable arrangement and lucidity of the paper, said he was so much in accord with it, that it was only necessary to refer specially to one or two points. He had the honour, some twenty years ago, of presiding over a Select Committee to inquire into the policy which should be adopted with reference to public works in India, and they came unanimously to the same conclusion with regard to irrigation works that had been indicated in the paper. Anyone who would look at a map of India might see that the density of population in the various districts was just in proportion to the regularity of the rainfall, and it was, therefore, evidently useless to construct great irrigation works in a province like Lower Bengal, where in 19 years out of 20 there was ample rain. Scarcely any irrigation works had paid in Bengal proper, but in the North-West Provinces nearly all had been successful, and the same in Scinde and parts of the Punjab. Railways, on the other hand, were almost a panacea for the mitigation of famine, and it was very satisfactory to note that nearly every recommendation made by the Famine Commission for the extension of railways had been carried out, and these railways run through the very districts which were now affected; and but for their existence, no doubt the famine would have already entailed the loss of millions of lives. Two very difficult questions always arose in connection with famine operations: the first, the date at which the Government should apply to the public for assistance and co-operation; and secondly, whether the Government should interfere with private trade in providing supplies of food. The Government had been criticised—as their predecessors had been—for their tardiness in appealing to the public, but if any one thing was made clear in the paper, it was that nothing did more harm, in times of famine, than ill-regulated, unorganised, and gratuitous relief. The Indian Government had carried their operations for the relief of the famine into many spheres previously reserved to private action, and they decided that they could not, with any advantage, make an appeal to the public until they had worked out a scheme of action by which private charity could co-operate with their exertions, without in any way superseding them. The two great principles to be followed were, first to see that the daily amount of sustenance was sufficient, and secondly that it should be, as far as possible, uniform. The great difficulty experienced on former occasions and on this, especially in the central provinces, was the immense migration from place to place. The moment the idea got abroad that rather better terms or conditions prevailed in a neighbouring province—that there were relief works established or gratuitous relief given—than the people trooped in by hundreds of thousands, and there was an immense aggregation of emaciated individuals far beyond the power of the local organisation to deal with, and disease and mortality inevitably ensued. Again, the Government was sometimes attacked because it was assumed that they declined to interfere with private trade from some obstinate adherence to abstract principles of political economy. He could assure them that so far from being an abstract theoretical question, it was one of the utmost practical importance. It must be remembered that any Government took on itself an enormous responsibility if, with good reason, it interfered with private trade. In the famine of 1876–7, when the Government bought a certain amount of rice, it paralysed private trade, and to such an extent, that notices had to be issued, that no further maintenance would take place, and from that time to the end of the famine food grains to an enormous amount continued to flow in daily to the famine districts. Conditions might arise, under which it would be necessary to interfere, but the Government obtained the best advice possible, and were glad to find last month that the best people in the trade entirely endorsed the action of the Government. He did not say that if things got much worse it might not be necessary for the Government to interfere, but if it did, obviously the simplest plan wnuld be to import food for the supply of their own relief works; but then there would be the difficulty that the trade, knowing the Government were importing grain into a certain district, might hesitate to act there, and then the Government might have to feed practically the whole population, and if any miscalculation were made, a fearful calamity might be the result. It was necessary, therefore, to act with the greatest caution. He believed the theory was still adhered to by those who had had the largest experience, that taking India as a whole, there was never in any one year insufficient food for the people; and it certainly had been sustained in this almost unparalleled famine. The only criticism he felt inclined to make on the paper was that Sir Charles Elliott had slightly underestimated the dimensions of the calamity. So far as he knew, there had never been a period known when high prices had prevailed over so large an area as at present; consequently there was an intense pressure on a large mass of society outside those on the relief works, andin certain parts the number actually on the relief works was enormous. It was quite true there were only about 5,000,000 amongst whom the proportion on relief works was 10 per cent.; but in Allahabad the proportion a month ago was upwards of 12 per cent., and the population there was about 1,500,000. In Banda the proportion was recently 22 per cent., and was now probably 25 per cent.; in Jubbulpore the proportion was 12 per cent., and had since risen. He feared, therefore, that for a long time to come there would be intense pressure in all the central black district shown on the map; because there the spring crops had failed, and scarcity must continue until the summer crops were realised. He was glad to hear the allusion at the conclusion of the paper to the Central Provinces. The officers there had had a very heavy task imposed upon them. They had had to deal with a difficult country intersected by deep rivers, mountainous in character, covered with forests, and which had the further disadvantage of being inhabited by an aboriginal population of very low intelligence and vitality. Beyond that they were surrounded by native States, and there had been an enormous influx of emaciated paupers, and vagrants from the North-West Provinces and Banda. When a short time back a large mortality took place in one of the poor-houses, Mr. Lyall, the Chief Commissioner, made an inquiry as to where the individuals who died came from, and out of 117 in a week only 15 per cent. belonged to the district, although it was nearly 40 miles square, and many had travelled from 80 to 100 miles. Everything was done to try and pick up these individuals before they arrived at the last stage of emaciation, but the Central Provinces, more than any other, had this difficulty upon them, because there seemed to be a tradition that though there might be scarcity elsewhere, there was always plenty in certain of the valleys, notably in Jabbulpore. Under that tremendous strain several of the ablest officers had succumbed Speaking on behalf of the Indian Government, he had every reason to be grateful for the sympathetic attitude which the public and Parliament had adopted towards this distress. It was difficult to get into people's heads the enormous magnitude of th operations carried on by the Indian Government Some people seemed to think that if there were casualties in any one of the poor-houses, or if th local arrangements in any one part were not equal to the sudden rush or pressure which came upon them therefore the whole system of famine administration was insufficient. But that was just as reasonable as to say that because a sentry was surprised, or an outpost carried, that the whole army was inefficient and incapable. The public would, no doubt, maintain an attitude of vigilance and supervision. At th same time, the feeling which animated the great mass of Englishmen was, he believed, one of gratitude to those who, under the most depressing conditions, and at the risk of their lives, were carrying out the noblest functions which any administrators could discharge

Mr. MISRA said he was very pleased to see the large amount of private charity which was being shown in this country towards the inhabitants of India, which was a clear proof that Englishmen took a great interest in the destinies of the East. He thought it must be admitted that the action of the Government had been very slow in the beginning, and that in consequence several deaths took place, and it was his bounden duty to point out that there was no sufficient justification for the diversion of the famine fund money into military channels for the sake of the glorification of Great Britain. Having referred to the great pressure on the inhabitants in times of famine by heavy land taxation, he suggested that the remedial measures, which would tend to diminish the chances of famine in future, should be first extending the system of irrigation canals, making advances to the agricultural classes by the establishment of agricultural banks in times of distress at low rates of interest, and it was not thought advisable for the State itself to become the creditor of the people, encouragement should be given to private individuals to do so.

Sir JAMES MACKAY, K.C.I.E., said it had been clearly demonstrated that the present famine and any future famines would to a great extent be famines of labour and not of food. This was due to the great development of the Indian railway system. In Burma, where there was practically never a famine, there was a crop this year of 1,600,000 tons of rice, and it could be transported from Burma to Delhi at the freight of 8 annas a maund, so that practically it equalised the price between Delhi and Burma. At present the rice was carried from Rangoon to Calcutta at 4 rupees a ton. In the Orissa famine the rate from Rangoon to the Bengal coast was 37 rupees a ton. Steamers as well as railways, therefore, had done something to combat famines in India. He entirely coincided with the opinions expressed by the Chairman against interference on the part of the Government with private trade, except at the very last moment. He believed that if the rings which existed to keep up prices could only be broken down, in the course of a very little ime they would see a material reduction in prices all over India.

General RUNDALL, R.E., C.S.I., said he spent thirty years in India, almost entirely on irrigation works, either in their design, construction, or administration. The Famine Commission, in their report, gave a true description of the way in which the value of irrigation works should be estimated. If by the statement that canals could not be made everywhere the reader of he paper intended to convey that "the great systems" of canal irrigation were not everywhere practicable, it was so far true, but the general assertion, with the three conditions specified as essential to the successful construction of canals, is not correct, and is calculated to convey a wrong mpression. The term "canal" means simply a conduit for the conveyance of water for any purpose, but a "system" of canals for particular objects, say of irrigation, navigation, and drainage combined, is a more complicated matter. Therefore, the first condition specified for "a successful canal," viz., that the supply of water in the river to be tapped should be sufficient and permanent, is by no means essential. In the Madras Presidency, for instance, there are numerous canals led off from rivers wholly and solely for the supply of reservoirs, locally termed "tanks," in which is stored up the water necessary for the cultivation of the large areas of land dependent upon them. Such canals exist in every conceivable situation and elevation above the sea, their special office being to arrest as much of their flood waters as possible from rivers whose supply, while actually abundant, is nevertheless only spasmodically obtainable, and if not immediately so arrested, only flows uselessly to the sea, and is, therefore, altogether lost. It is the omission to notice, in the paper just read, this matter of storage as the primary and fundamental want of India on which he wished to offer a few remarks. The quantity of water that runs to waste along the great rivers is almost incalculable, and a large portion of it can be arrested at those levels which command the places where now irrigation seems impracticable. In the whole of the Madras Presidency there are about 5,000,000 or 6,000,000 acres irrigated, but only about one-half or less is irrigated by rivers. The rest depends on reservoirs, and if the local rain fail famine follows. But it is not impossible to supply most, if not all, of these by large storage reservoirs on the upper branches of the principal rivers. There are several old native works now in ruins which might be restored, and, he believed, on the upper reaches of the great rivers might be found many admirable sites for very extensive reservoirs. Great stress has been laid upon the extension of railways since the last famine as the main panacea for the prevention or mitigation of famines. In so far as they are means for conveying produce from one part of the country where it is abundant, to another where there is little or none, they of course are fulfilling their special office to the great advantage of the community—but with this drawback—as has been before pointed out by Indian statesmen, they lead to great speculation, if not of "cornering" amongst the grain merchants, which creates so great a rise in prices locally as to be tantamount to the effects of a scarcity. It has been asserted that India now produces enough food for the whole of its population, but how this can be maintained in the face of the large contributions from Burma and other countries as stated by a previous speaker, passes comprehension. As railways, therefore, cannot produce a single grain of food, they can at best be considered as an auxiliary, however effective they may be, in its distribution. Surely it is far better to provide the means for growing food in every district in India than to expend millions of money, and exhausting energy in transporting food from one distant locality to another. Hence he maintained that the storage of water is the primary and fundamental want in India, whose rainfall though superabundant in certain localities is confined in all to but a few months in the year, and is then often capriciously distributed. The great delta works in the Madras Presidency, whose value is well known to persons conversant with irrigation works in India, are, however, but little known to the English public, for whose information this meeting has been arranged. Attention may, therefore, be properly directed to a late official publication by the Madras Government in which the extraordinary results of the great Godavery delta works designed by Sir A. Cotton are fully and accurately described, a document which should be supplied to the libraries not only of professional institutions, but to those of our public bodies, and especially to Parliament, just now so deeply moved and interested in the calamity which has befallen our greatest dependency. While attention has been specially directed to the beneficial transport by railways, no allusion has been made in the paper to the subject of water transit, which it seems almost superfluous to add is so much cheaper than any means of land carriage. Had the opening of the river Godavery been completed instead of being suspended in the middle of the operations, grain could now have been transported along the 350 miles of its course to the Central Provinces, the tract which is feeling the acutest pressure of famine. Instead of the various lines of railway from Bombay being taxed to their full powers for conveying grain procured from beyond sea, to the interference of the legitimate and ordinary traffic of the country, a full food supply would have been conveyable by independent steamers and native craft such as is being now done on the Orissa Canals, and Nuddea rivers in Bengal without any inconvenience to other trade, and landed at the various marts on the river bank at the cheapest possible rates. The amount of traffic that passes along all the delta canals and along the minor as well as the greater rivers in Bengal is perfectly astonishing, and surely ought to serve as an object lesson as to the direction in which expenditure on modes of transport should be made. General Rundall, in conclusion, trusted that these two fundamental points of storage of water and the extension of water transit may receive more attention as essential measures towards the prevention and mitigation of famines in the future than they have in the past.

Sir CHARLES CROSTHWAITE, K.C.S.I., said everything that had been stated by Sir Charles Elliott with reference to the North-West Provinces was strictly accurate. The actual famine of food in those Provinces so far as he understood it was confined to the Bundlecund district, and some of the southern parts of Oudh, where what was called the autumn harvest had failed, and cultivators had been left without that store of grain which supported them in the cold weather. In those parts and in that portion of the Allahabad district which adjoined them there was an absolute want of food, and that was the reason why the numbers on the relie works were so high. As a rule the famine was to use the words of a previous speaker, more o labour than of food. The people in distress were th labouring classes who could not get occupation ; much in the same way as a severe frost threw out of work the labouring classes in England, so a severe drough threw out of work the agricultural labourers in India. In the districts to which he referred where the autumn harvest had failed, the population were always more or less poor, and there the distress had undoubtedly reached the cultivatin classes, and the famine was severe. It was difficul to irrigate the soil of Bundlecund with advantage and the Betwa Canal had proved almost a failure for the people had not taken the water. H doubted very much whether any canal there would b of much service. It was easy to blame th Government. But when prices doubled he di not know how any power on earth could prevent th poorer classes from suffering. If the prices of all th necessaries of life were doubled in England, the poor houses would not contain the number of people wh would be starving and destitute, and it was just th same in India. Fortunately, severe droughts onl happened at long intervals, and the Government wa enabled owing to the organisation, which had bee the outcome of the Famine Commission, and of whic Sir Charles Elliott was the chief originator, to dea with this famine in a way with which the people c England ought to be satisfied. No one could den that there was great mortality. There must be. N human power could prevent people dying both from want of food and from disease, under such circum stances, and over an area so vast. But everythin was being done that could be done to mitigate th sufferings of the people. Knowing the officers in th North-West Provinces, he was quite certain that s far as flesh and blood could avail, they would wor until they dropped. His successor, Sir Anthon Macdonnell, had shown himself well able to cope wit the enormous difficulties he had to deal with, and M Charles Lyall was also dealing admirably with th great district in the Central Provinces. Th Chairman had explained the exceptional difficult which the Central Provinces administration had t contend with, owing to the sudden influx of starvin people from adjacent districts. In the famine of 18 he was Commissioner at Jubbalpore, and or morning in October, he got a telegram from th officers on the border, saying that thousands we crossing into the Central Provinces from the north west and from the adjacent native States. H immediately went off to Saugur, and found th road from the railway to Saugur, a distan of some fifty miles, was thickly covered wi a regular exodus of people from the North-Wes bringing their carts, goats, and everything. They told him they were afraid nothing was going to be done for them in the districts from which they came, and they had heard from their fathers or grandfathers that in the year 1837, when a great famine occurred in the North-West, their village had to come down to the Central Provinces, and there they found grain selling at a fabulously cheap price. It was no use telling them that things had altered, they would not believe it, and, no doubt, the same thing was happening to a great extent now.

Mr. JULIEN LOUIS said that during the last forty years they had been face to face in India with six important famines, in each of which a large number of people perished, notwithstanding the immense extension of the railway system, extensive schemes of irrigation, and the excellent provisions of the Famine Code inaugurated by Sir Charles Elliott himself. In a country like India, which is a large food-producing and exporting country, vicissitudes of this sort should not happen, and the lesson it taught by the present calamity probably would be that it was as impossible to provide for the food of the people of India without a local reserve of food stuffs as it would be to carry on the commercial business of a country like England or France without bank reserves or treasury balances. It had been asserted that a reserve of say 1,000,000 tons of grain would feed 10,000,000 of people for six months, and this would be sufficient for all practical purposes. It could easily be seen that such a reserve could be made without any expenditure but at a profit. It was well known that during periods of scarcity prices rose to a degree which was not justified by the extent of the scarcity, and in every year before and after the harvest there was a difference of say 10 per cent. in the price of the grain. If, therefore, the Government purchased the stores at the right time there would be available a portion of that very large margin to cover the cost of maintenance and management. The two great causes of distress were first the utter disorganisation of the agricultural labour market, there being little or no work to be had, and that little at depreciated rates; secondly, the abnormally high prices to which food stuffs rose. The first could only be relieved by relief works, but the second would be very much relieved by local reserves of food given, which would also tend to equalise prices. A reserve of food grains distributed all over the country, and which could be placed on the market periodically, immediately before harvest time, and in times of scarcity would equalise the prices of food in the same way as bank reserves regulate the price of money; and when we have such a reserve, in addition to a railway system, which is approaching perfection, sufficient means of irrigation, and an improved famine code, such calamities as the present will become an impossibility in India.

Sir CHARLES ELLIOTT said very little had been said which called for any reply. The only definite suggestion made was that which he had just heard from Mr. Louis. But he would remind him that the Famine Commission carefully considered this subject of storage, and worked out the arguments and the calculations, and showed how extremely expensive a stock of grain would be which had been deposited in a granary, perhaps, in the year 1880, and kept against this famine, a large portion of it suffering from weevils, and only fit to be thrown away, so that the small portion remaining would have to bear the cost of the original price, the interest on the money, and of the wages of the establishment required to take charge of it. Perhaps Mr. Louis had not seen the famous building called the "Gola," erected at Patna after the famine in 1879, which bore on its doorway the magnificent inscription, "For the perpetual prevention of famine;" that granary had never been filled, and if it had been it could never have served the purpose for which it was intended. Even if it had preserved a certain quantity of grain, that quantity would have been nothing compared with the demands of the starving population, and would have been maintained at enormous expense. He would remind General Rundall that he was not taking a universal survey of everything done in India, but merely stating what the Famine Commissioners recommended, and how far it had been carried out, and no specific recommendation was made by them on the subject of irrigation from tanks. The great difficulty with tanks was that they were liable to be dried up. They gave plenty of water when people did not specially want it, but in a drought they were nearly empty. At the same time, in ordinary years, they served an enormous field, and contributed largely to the great extent of the irrigated area to which he had referred. With regard to what had fallen from the Chairman, who seemed under the impression that he had been too sanguine with regard to the prospects of the present famine, he could only say that it was not his intention to prophesy at all as to how the famine would end. His object was to show the facts as they existed in a picturesque way, basing his classification on the quantity of people now on relief works, not to draw any conclusion as to what further developments might take place. But it was his impression that a certain portion of the country which had been thought to be in danger might now be considered out of any serious danger. With regard to the whole of the Punjab and almost all Madras he thought there was certainly less reason to anticipate danger than there had been two months ago.

Sir CHARLES TURNER, K.C.I.E., said that in reference to the complaint which had been made that the action of the Government was too slow, and that delay had occurred in instituting measures of relief, he desired to refer to his own experience during the famine of 1877. In that year he visited a famine district in which relief works had been opened within ten or twelve miles of every village, yet persons were found dead by the wayside before they could reach the works. Nothing would induce an Indian peasant to leave his village so long as he could procure even the smallest quantity of food there. Such deaths must occur in every famine. Until full reports were received it could not be definitely stated when each local administration did begin to undertake the matter in hand, but this he could say, that long before scarcity had deepened into famine the local governments were aware of the impending danger, and had already taken measures to put the famine codes in force, and that officers had applied to and received assistance from generous friends in England to alleviate local distress. The public would be well advised to suspend its judgment on the action of the several administrations until complete narratives of their operations had been received.

Mr. W. S. SETON-KARR writes :—I should wish to add a few remarks on Sir Charles Elliott's interesting paper as I did not wish to prolong the discussion at the meeting of Thursday. I approach the subject from a point of view somewhat different from other speakers. Since my retirement from the Bengal Civil Service, I have been, for 21 years, an elected guardian of the poor in the parish of Chelsea, and have naturally acquired some experience in the administration of relief, both in ordinary years and in times of pressure and scarcity. Now, roundly speaking, in London and in the suburbs, the Poor-law is administered by some 40 Boards of Guardians with their relieving officers, and all the other officials necessary to the working of the system. The population of these 40 districts may, also roundly speaking, be set down at 5,000,000. In addition to Boards of Guardians it is well-known that there are other agencies which give help to the suffering poor, such as the Society for the Relief of Distress, the Charity Organisation Society, and others, to say nothing of the numerous incumbents of parishes, with their district officers and visitors. Now, if the area and population alluded to above were suddenly to become the scene of a visitation as severe as that which has fallen upon vast provinces in India, I will venture to say that, in order to deal effectively with scarcity, fever, and famine, all the existing machinery for relief and assistance, so far from sufficing, would have to be multiplied sevenfold. And be it remembered that in a capital like London, though the population is vast, the area of privation or scarcity is comparatively limited. Every portion of it is easily traversed, and some machinery of official or charitable relief has been in active existence for a very long period of time. In India, as those present at the meeting know perfectly well, a Poor-law is unknown. In ordinary times, the feeble, blind, or aged poor, in towns and stations, are constantly relieved by private charity; and Hindus and Mohammedans of the better class are never backward in helping the sick and the afflicted sometimes without distinction of caste or creed. B there is in India nothing like a regular or establishe agency for the distribution of food or money; a thus when a great calamity of this sort happens, gigantic Poor-law must start into life and must wo over districts as large as English counties, and ov provinces equal to European kingdoms in extent. must operate in large towns; over sprawling villag buried in an artificial jungle of the ryots' own making in backward and half cultivated districts, and und difficulties utterly unknown in England. It is pe fectly true, that warned by previous experienc Indian administrators have learned to deal effectivel with famines, and at short notice are able to crea relief works, hospitals, rest-houses, and to distribu help to huge numbers of starving poor, either money or in kind. All this has to be done whe the population affected is not 5,000,000 b 50,000,000, and by native agency, which has be watched very carefully to prevent laxity fraud. The official Englishman is terribly ove worked, and it may be said that from t Lieutenant-Governor and the Commissioner, dow to the District Officer and his subordinates, eve member of the Civil Service is subjected to strain almost too great for human nature. It admitted that the development of the railway syste has largely contributed to the means of relief. F 5,000 miles of railway in 1868 and 1869, there a now 18,000 miles open, and in working order. Bu still, the ordeal is very severe, and I could pursue t topic to greater length, having myself witnessed t effects of two famines alluded to by previous speaker and as I realise the distances to be traversed, t vastness of the population, and the impediments an restrictions of prejudice and caste, I feel full justified in asserting that the Indian Government an its officials have not been taken by surprise, but th they are employing measures for the relief of o fellow subjects with a zeal and energy which oug to silence ignorant and malicious criticism by write or speakers elsewhere, who have no knowledge even the beggarly elements of the problem whic they have undertaken to settle off-hand.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 17, 1897; SIR WILLIA CLEAVER FRANCIS ROBINSON, G.C.M.G., i the chair.

The following candidates were proposed f election as members of the Society :—

Ashley, Right Hon. Evelyn, 13, Cadogan-square, S.W
Eastlake, Arthur William, Fairlawn, Temperl road, Balham, S.W.
Goulding, Frederick, Kingston-house, Shepherd' bush-road, W.

Hentschel, Carl, 182, Fleet-street, E.C.
Osborn, Ashby Frederick, Cowra, New South Wales.
Smith, Edward, 75, Gore-road, South Hackney, N.E.
Xavier, Isidore M., Water Department, Victoria, Hong-Kong.

The following candidates were balloted for and duly elected members of the Society:—

Browne, J. Harris, Hadley Brewery, Barnet.
Coombes, William Henry, 32, Northwood-road, Highgate, N.
Gunter, James, Estate-office, Glasbury, Radnorshire.
Morgan, Herbert, Alderley Edge, Cheshire, and Ducie Mills, Manchester.
Nicholl, William, A.R.A.M., 8, Weymouth-street, Portland-place, W.

The paper read was—

MUSIC IN LONDON AT THE QUEEN'S ACCESSION.

By J. Spencer Curwen.

It is pleasant to recall the musical observances which welcomed the young Queen of 1837 to the throne. They are interesting, not nly as a proof of the loyalty of our fathers, ut as shedding light upon the musical ideals nd tastes of the period. The Queen was born t seven o'clock in the morning, and at ten ninutes before that hour on the day of her egal majority, May 24, 1837—William IV. was till reigning—a party of thirty-seven gentlenen entered the enclosed area round Kenington Palace to serenade the Princess ictoria, heir presumptive to the throne. Mr. Veippert was in command, and the party conisted of the band of the Italian Opera and our vocalists. The band probably played by hemselves; the vocalists, true to old English abit, were glee singers, and they sang three lees—"Wake, royal maiden," "The fairest lower of May," and "Victoria's natal day"—ll composed by George Herbert Rodwell, a rominent musician of the day, winding up vith "God save the King." A breakfast at he "King's Arms" Tavern was a natural ecessity after this loyal effusion. The glees vere published. I have not seen them; no loubt they served the need of the moment.

Lord Mayor's-day of this year found the oung Queen paying her first visit to the City, nd on this occasion music played its part. ver the porch entrance to the Guildhall was he orchestra, erected for fifty vocal and nstrumental performers. Sir George Smart ffered his gratuitous services as conductor. uring dinner, the orchestra played several ieces. As soon as the cloth was removed, the Queen rose, and "Non nobis domine" was sung by the principal vocal performers. After the Queen's health, "God save the Queen" was given in chorus. The health of the Lord Mayor was followed by Callcott's glee, "Hail, happy Albion." The health of the Royal Family was followed by a chorus from Mozart's "La Clemenza di Tito" ("Serbate O Dei Costodi"), adapted to the words, "All hail our Queen Victoria." Then, after a pause, Shield's glee, "O happy fair!" was sung:—

> "O happy fair!
> Your eyes are loadstars, and your tongue's sweet air
> More tunable than lark to shepherd's ear."

Here, no doubt, was a personal reference to the young Queen. Our fathers knew how to offer a delicate compliment. These details I take from the official report, which also states that the expenses were: a gift to Sir George Smart, 20 guineas; for his performers, £81 2s. 6d.; and Mr. Harper, for trumpets in the hall, £11 3s. The *Musical World* report says, that, in addition to the music already mentioned, the following glees were also sung: Bishop's "When the wind blows," Cooke's "Hark! the lark," Attwood's "In peace, love tunes," and Bennett's "All creatures now."

The accession of the Queen gave rise to many pot-boilers from the music shops. There were even comic songs published about her visit to the city. The Sacred Harmonic Society sang a special anthem by George Perry in praise of the new monarch, and we may be sure that unnumbered glee clubs and harmonic unions followed suit.

The coronation took place in the next year, June 26, 1838. As the Queen walked up the Abbey and entered the choir, "I was glad," an anthem by the then organist of St. Paul's, Thomas Attwood, was sung. At the recognition, after the general acclamation, the trumpets sounded, and "God save the Queen" was played. The choir read the responses to the Litany. In the Communion Service, Sir George Smart's setting of the Sanctus and Responses was sung. After the gospel was named, the Gloria Patri was sung. After the sermon was ended and the Queen had taken the oath—I am quoting from the official order of the music—the hymn "Come Holy Ghost, our souls inspire," was sung to *the Grand Chant* (organ accompaniment only), the first line being read by the Archbishop. The hymn is printed in couplets of two lines each, the couplets being numbered like verses, apparently to fit the chant. It seems evident from this that the hymn was sung to Pelham Humphrey's Grand Chant, a proceeding that seems curious to us to-day. Then, after a short prayer, came Handel's anthem, "Zadock the priest." When the Queen was crowned, the trumpets sounded. After a short prayer, the third anthem was sung:—"The Queen shall rejoice" (Handel). After the Benediction came Dr. Boyce's *Te Deum* in A. During the homage the fourth anthem was sung:—"This is the day the Lord hath made," by W. Knyvett, Composer to Her Majesty's Chapels Royal. When the homage was ended the trumpets again sounded. Next came the fifth anthem, Handel's "Hallelujah Chorus"; and, lastly, after the blessing, an instrumental piece.

The young Queen had a musical reputation. Sir George Smart is reported to have said at the Guildhall dinner already referred to, "We must be very particular, for if we are at fault, Her Majesty's ear will detect our blunder." Newspaper paragraphs of the day speak of the Queen often singing to her Court at the Brighton Pavilion. "Her Majesty," we are told, "sings light Italian airs with considerable sweetness and judgment, indeed far better than some professional singers." The Duchess of Kent also sang; and the Duke of Cambridge, father of the present Duke, took a house at Dover, and summoned Blagrove and Housmann to go and play quartetts with him and his secretary. The *Musical World* addressed the Queen on her accession, hoping that she would protect and patronise the British musician. Has Her Majesty done so? The cult of Italian music and musicians was at its height when Her Majesty's taste was formed, and it has had its place at Court longer than in the nation at large. Ideals in art are not easily changed.

Speaking for the moment of a later period, it is impossible to pass over the excellent influence of the Prince Consort on high-class music in England. Of his practical musicianship and good ear there is abundant testimony. He chose programmes for the Antient Concerts, 1840-1848, and for the Philharmonic Society, 1843-1860. A chamber band of wind instruments of seventeen members was formed under Mr. Anderson soon after the Queen's accession, but the Prince Consort had this reorganised, in the year of his marriage, as a stringed orchestra. He attended the Opera, the Sacred Harmonic Society, and had State concerts at Windsor, at which oratorios were performed. His published music is known. The Prince desired that music should be universally taught in the national schools. So much for the personal relationship of Her Majesty to the music of the period. We now turn to the nation.

Step back sixty years! Place yourselves in fancy in the London of 1837—what a change of atmosphere! For houses, streets, population, traffic, wealth, divide our London by four to get the London of the year of the Queen's accession. Enter in spirit the mind of the period, and see the people as they were. Indignation meetings were being held against railways, and especially against the dangers of railway tunnels. The first omnibus had been started eight years before, and the fares were still high. A Londoner who had a daughter at the Royal Academy of Music says he paid in the year thirty-five guineas for her fees and fifteen guineas for her omnibuses. Precentor Dickson, of Ely, happily still living, spent ten pounds, as a boy, in coaching from Yorkshire to Devon, and the journey took him the greater part of three days and nights. Dragonetti, the double bass, paid £28 for coachmen and guards, to and from London, to the Liverpool Musical Festival of 1836. When he got there he was too ill to play, and the committee only gave him £10. Hopes were expressed, after the Birmingham Festival of 1837, that the new railroad would be completed before the next festival came round. One of the band, a Londoner, who got six pounds for the week's work, says he walked a good part of the way, both down and up. The cost and difficulty of movement was compensated for by the smallness of London. Musicians lived near each other. Regent's-park and the City-road were suburban Adelphi-terrace and Berners-street, then residential places, covered the extremes. Conjure up the men of the period. Old gentlemen might still be seen wearing the pig-tail, knee-breeches, silk stockings, while some walked out in Hessian boots. The Spanish cloak fitted in with a Byronic melancholy. Any day, one's honour might demand an early visit to Battersea-fields, with coffee and pistols for two. The ladies played the piano-forte and guitar, copied the old masters in wool-work, and studied the language of flowers For amusement, people went to Surrey-gardens Vauxhall-gardens, White Conduit-gardens, to see the "Eruption of Vesuvius," or "The Hermit at his Devotions." For health, they took the waters at Beulah Spa, Norwood. Writers who were producing books at the time, included Carlyle (whose "French Revolution" was one of the publications of 1837), Captain Marryat, Maria Edgeworth, Harrison Ainsworth, Bulwer Lytton, Disraeli, Washington Irving, Tom Hood, and last, but not least, "Boz." Living, but past he productive period, were Southey, Tom Moore, Wordsworth, Thomas Campbell, and Miss Mitford. Scott had been dead five years, and Lockhart's biography of him, which appeared during the year, was eagerly devoured. Mrs. Hemans, Coleridge, Charles Lamb, Byron, and Shelley were not long dead. Mrs. Brown- ng's first book was not to appear for one year, hough her husband's "Strafford" was produced this year at Covent Carden, with Mac- eady. Thackeray, Charlotte Bronte, Trollope, Kingsley, and George Eliot were unknown. Darwin, a young naturalist, had come back he year before from the voyage of the *Beagle*, and was reflecting.

Place your finger on the musical pulse of he time. Handel had been dead 78 years. There were certainly some people alive who had been born in his lifetime, and possibly some also had seen him as children. Hundreds of musicians knew him, only at econd-hand, through their teachers. It was but ten years since Beethoven, lying on his death-bed, had been cheered by a gift of £100 from the Philarmonic Society. Old men emembered Mozart, whose widow was still alive; middle-aged men remembered Haydn; Schubert had only been dead nine years; Wagner, at 24, had composed an unperformed opera; but *Rienzi*, *The Flying Dutchman*, *Tännhauser* were unborn. *Elijah*, too, was not written; Gounod, a youth of 19, was tudying at the Paris Conservatoire; Brahms was a child of four; Grieg, Dvorak, Sullivan, Tschaikowski and Bizet were not born.

Oliphant, writing in 1835, says that the great tar in the musical hemisphere for the last wenty years had been Rossini. He, himself, has often been called upon at friends' houses to take part in Italian duets and trios, which are far removed in style from the intellectual music of Elizabeth's time. The Italian Opera had a strong following, as it still has, among the pper ten, and the Italian singers were many f them giants—Grisi, Pasta, Ivanoff, Rubini, Tamburini, Lablache. In the operas produced, Bellini, Donizetti, and Rossini had most favour; Costa brought out his *Malek Adel*, nd Mozart, Zingarelli, and Mayer were also eard, while opera bouffe was represented by Ricci and Paer.

Determined efforts were made during the year to establish English opera. Bunn took the English Opera-house, and several new works were brought out. Hullah produced two operas during the year—the *Village Coquettes* and the *Barber of Bassora*. Balfe's *Joan of Arc* and *Catherine Grey*, also products of the year, belong to the Italian school, but W. M. Rooke's *Amilie, or the Love Test* was genuine native opera; the composer, Rourke by name, hailed from Dublin. John Barnett had made a great success with *The Mountain Sylph* in 1834, and this year produced *Fair Rosamond*. Sir Henry Bishop's best work had been done. He had sacrificed quality to quantity, and his influence had declined. In 1833, G. H. Rodwell had drawn up and published an impossible scheme for the granting of a patent to British musicians for a grand national opera. There appear to have been at that time no performing fees, so that a composer was only paid by the sale of copies of his opera or its songs. "Composers," says Rodwell, "have to write for the boarding school if they would live." I have heard something of the sort said in our own days.

A *Gallerie lebender Tondichter*, published in Germany in 1836, had given but one portrait of an English composer, and that was of John Field, in whom it is difficult to detect any English strain. This shows how low English art had sunk in European reputation. John Barnett, writing of the year 1832-3, says that English vocal art was then at its lowest ebb. Shield and Storace were no more; Bishop had passed his zenith and was resting on his laurels. Mawkish and common-place ballads prevailed. Barnett's "Lyric Illustrations" are really marvels of freshness and dramatic force when we consider that they belong to this period.

In social life music was not much cultivated. Nevertheless it was highly esteemed by the few, and very high-class concerts were given in London to small and select audiences.

In the first rank were the Antient Concerts, which had been founded in 1776 by George the Third, and where only the music of composers who had been dead at least twenty years was performed; the Philharmonic Society, then, as now, high toned and cautiously progressive; the Societa Armonica, an orchestral body; the vocal concerts, where songs, glees and madrigals were sung; the classical and chamber concerts; the Moscheles pianoforte soirées, &c. Most of these societies met in the Hanover-square Rooms, and the audiences were what we should call small. There was only one price—half-a-guinea—for seats. Concerts of this class had not yet been popularised.

Next to these came a group of societies which met further east, or in the city. The Choral Harmonists had been started in 1832, and sang Handel, Mozart, and Haydn. So did the Melophonic Society. The Cecilian Society, older still, of the same class, met in Albion-hall, London-wall. The City Classical Harmonists was another union; indeed, Chorley, in a review of the year's music in the *Westminster* for July, 1837, says he could name a hundred smaller societies in active work in the metropolis. The Sacred Harmonic Society, started in 1834, was the greatest of all. What it did may be judged by a remark of George Hogarth in the *Morning Chronicle*, May 27th, 1837:—"Within these few years the performance of an oratorio was a thing unknown in London, except for the festivals in Westminster Abbey and the Lent Theatre performances." The society rose rapidly to a high position, and in 1837 was working on what was then considered a large scale. It went in for cheap prices—three shillings for unreserved seats, and five shillings for the new gallery. At literary institutes and mechanics institutes musical lectures were given.

By themselves stood the clubs which combined dining with music. Senior among these was the Madrigal Society, then approaching its centenary, the oldest musical organisation in Europe. Then, as now, the members dined, the boys came in, music books were placed upon the table, the ponderous wooden pitch-pipe sounded, and the ever fresh counterpoint of Wilbye and Gibbons sprang upon the air. This year, Sir John Rogers was president of the society, William Hawes musical director, and Thomas Oliphant honorary secretary. Oliphant, who was a stockbroker, published in 1837 his *Musa Madrigalesca*, containing no less than 397 sets of English words for Italian and Flemish madrigals—some translations, some imitations—all of which show the master hand. His words to-day have lost none of their freshness and dainty manner. This was the high-water mark of the Madrigal Society. One hundred and fifty people would dine at its board. An article in *Bentley's Miscellany* for this year speaks of the society as the very Royal Exchange of musical enthusiasm and good fellowship. Besides the Madrigal Society, there was a Purcell Club, and many glee and catch clubs. Prizes for glees and songs were constantly given by these clubs, and seem to have stimulated composition.

One may detect a growing note of self-reliance and independence in the musica discussions of the year. The dark period fo English music, which began with the death o Purcell, was coming to an end. Chorley remarks that Naples and Vienna run some risk of being abandoned as the capitals o music for Paris and London. This reaction found expression most strongly in the Society of British Musicians, which had been founded three years before, and was now well established and prosperous. The critics laughed at it. This "Great-Britain-agains all-the-world-society" they called it. The rules forbad the performance at the concerts of any music by foreigners, or indeed of any music by others than members of the society To say that such rules were narrow and bigoted was to overlook the special purpose of the society, which was to get a hearing for the British composer at a time when the public would listen only to foreign music. The leaders of the society were cosmopolitan in taste—Cipriani Potter, George Macfarren, Henry R Bishop, W. H. Holmes, Sterndale Bennett John Hullah, John Barnett, Charles Lucas J. M. Mudie, James Calkin, John Goss. In other connections they were constantly engaged in welcoming foreign musicians and performing their music. They adhered, however, to the special aim of their own society. What difference has sixty years made in the state o things which prompted this society? Does no the British composer still feel that in this country he is handicapped in favour of th foreigner?

The Royal Academy of Music had been established fourteen years, and its first pupils were becoming a force in English music. Thi fine old institution, which has trained severa generations of our musicians, at once expressed and inspired the renascence: I am glad tha it so well maintains its prestige to-day. A few voices, crying in the wilderness, were beginning to preach Sebastian Bach. Writes Gauntlett then a lawyer, "Sebastian was the fount from which Haydn, Mozart, and Beethoven drank the stream of immortality," and in our own day we see but the reflection of his mind in the works of Samuel Wesley and Mendelssohn." Writes Egerton Webbe, grandson of the glee writer:—"Musical composition will be a very different affair with us from what it is now when the works o Sebastian Bach come to be employed for the purposes of study. They form a fountain of harmony able to irrigate and fertilise the whole world of music for a thousand years." Other eading writers were George Hogarth, of 'Musical History," and G. F. Graham, of he "Music" article in the "Encyclopædia Britannica." Both works appeared this year. Two overtures by the young English school which time has approved, were played for the irst time in 1837—Sterndale Bennett's *Naiades* and Macfarren's *Chevy Chase*. Pearsall, too, was producing his vocal works, so melodious and so scholarly. Two great works by German composers were also brought out; Mendelssohn's *St. Paul* at the Birmingham Fes-ival and Spohr's *Crucifixion* at the Vocal Society. Edward Taylor wrote English words o Spohr's work, and published the pianoforte core for thirty shillings. Alfred Novello brought out the English edition of *St. Paul*, pianoforte score, thirty-two shillings; vocal parts five shillings each. What prices our athers had to pay for their music! To save he cost of buying they copied it by hand. Who does not know the faded yellow leaves of manuscript music, in the dear handwriting, hin and pointed, of mother or aunt, dating rom the thirties and forties! The church hoirs and choral societies sang from single parts copied in the same way. The cheapening of music printing, due to the use of types, is one of the most striking advances of the Victorian era.

For theory, the student who could not read French or German had to work through the mist of translation. The apostolic order was Marpurg, Albrechtsberger, Reicha, Fetis, and Cherubini, the last of whom was still alive. An English translation of Cherubini was issued his year by Robert Cocks and Co. English tudents have now the advantage of studying rom works written by Englishmen.

The English singers of the period were Mrs. Seguin, Mrs. Knyvett, Miss Birch, Clara Novello, Mrs. Bishop, Mrs. Shaw, and Messrs. Alfred Novello, Braham, Hawkins, Vaughan, Hobbs, and Phillips. John Parry, the Gros-mith of the day, took his farewell. R. J. S. tevens, the glee-writer, died; but the most otable loss of the year was Samuel Wesley, he significance of whose personality has not een lessened by time. Foreign visitors of the ear included Mendelssohn, who came to con-uct his new oratorio. At St. Paul's Cathedral e played after service on Sunday afternoon. The vergers tried in vain to drive the people ut; failing this they persuaded the blower to stop blowing in the middle of a Bach fugue. Mendelssohn also played at Christ Church, Newgate-street. Chopin, pale and emaciated by consumption, paid a twelve days' visit to London. Conversation made him cough, and he shrank from society or the effort of playing in public. Ole Bull, the Norwegian violinist, was also here. If we imported largely in music, it is pleasant to note that we exported Blagrove, the violinist, who went to play at Saxe-Meiningen. Sir George Smart was the Costa and Richter of the day. He did not compose, so the present generation has forgotten him. Absolutely punctual, rigid, methodical, he was born to command. Mendelssohn, according to Chorley, was a magnetic conductor of his own works, but in other music lively rather than certain, fretting his band and being fretted by them. Benedict had already established himself, and Costa's nerve and vigour were recognised. John Ella had commenced his mission to the select few. Mr. Chappell was sending out feelers for his interesting work on old English music. The publishers of the day included Chappell, Cocks, Mori, Dean, Lonsdale, Purday, Ollivier, Munro, Holloway, Alfred Novello (just starting), Jeffreys, Wessel, Coventry and Hollier. Editions of Bach, Chopin and Mendelssohn were issued during the year. Among minor English composers of the day may be named Henry Smart, E. J. Loder, J. P. Knight, C. E. Horn, George Hargreaves, J. L. Hatton, J. W. Hobbs. An oratorio by Sir George Elvey was produced. Ewer began the issue of "Orpheus," which opened up the German male voice part songs to English singers. Here I may mention one or two musicians still living who were at work in 1837:—Miss Mounsey, Mr. Charles Salaman, Mr. Henry Russell, Mr. Kellow Pye, Mr. Joseph Robinson, of Dublin. The list, no doubt, is incomplete.

What was the condition of pianoforte music? It was the period of the fantasia, of variations, of Thalberg, Henri Herz, and Bürgmüller. A musical journal of the day calls Herz "The great musical mountebank," and deplores his despotic sway. But these men only followed the fashion. Mr. Walter Macfarren, who was a student at the Academy some years later, says that he was trained on Thalberg, Herz, Hummel and Pixis. In four and a-half years he had only one Beethoven sonata, and heard nothing of Bach. Even Mendelssohn's pianoforte works were slow to make their way. Hogarth, reviewing the first English edition of the "Songs without Words" (*Morning*

Chronicle, September 18, 1837), says they "are as yet almost unknown in this country." Moscheles, however, was editing Beethoven's sonatas, and the tide soon began to turn.

I suppose Thomas Adams was the greatest organist of the day. He is everywhere highly placed: "the Thalberg of the organ" someone calls him. But the organ of 1837 was not that of 1897. Many organs had no pedals, and the great players of the past had brought manual dexterity to a high pitch, playing the organ as they did the harpsicord. The manual bass was often incomplete, and the imperfect pedals, when they began to come in, were often neglected by the players, who would use them only for a pedal point in the harmony, or to fill up a full close. As the organ music of Bach and Mendelssohn came to England, the desire for the German compass and pedals spread. The organists attached to the Chapel Royal were Attwood, Elvey, Gutteridge, Knyvett, Roberts, and Sir George Smart, with Massey and Cooper as deputies. Elizabeth Stirling, a pioneer woman organist, was a pioneer also in her love of Bach. Her remarkable performances during this year of Bach's pedal fugues in St. Katherine's Church, and in St. Sepulchre's, are noticed in the journals of the day. Miss Mounsey, who is still living, was appointed organist of St. Vedast, Foster-lane, in November of this year. The organ builders of the time include names still familiar—Gray and Son, Robson and Sons, Hill and Davison. Equal temperament was coming in, and General Thompson, a Radical M.P., was preaching just intonation by means of his enharmonic guitar and organ, a matter in which we seem to have made no practical progress since.

There was much talk in this year of the low condition of the music at St. Paul's. The period represented a pause in musical as in spiritual thought; the stir of the Oxford movement was not yet felt. Attwood, the organist at St. Paul's, was, however, seventy years of age, and had held his post for forty-two years. Gauntlett, spying out the nakedness of the land, heard Greene's "O clap your hands" sung at St. Paul's by four male voices and full organ, and an anthem of Dr. Hayes' by two counter tenors and a tenor. If they sang he could not tell, for the organ carried all before it. The days of Kent and Jackson were however numbered, and the new life was coming. Miss Hackett had begun her interest in the cathedrals and was offering her Gresham prizes.

In the parish churches music was muc
neglected. The service was said, not sun
Even the canticles were spoken. Tate ar
Brady's metrical Psalms, sung by a fe
charity children in the west gallery, repr
sented the music. Psalmody, in the mind
writers of the period, means the singing
charity children. Printed at the end of t
Prayer-book were the morning and evenin
hymns, the angel's hymn ("My God and
thy table spread"), and for the festivals t
Easter hymn, "Veni Creator" for Wh
Sunday and the "Adeste Fideles." He
and there, on rare occasions—a sort of sanc
fied dissipation—a church rose to "Vit
Spark," "Jackson in F," or "Luther
Hymn" with trumpet obbligato. In tow
the usual accompaniment was the bar
organ, that is to say, an organ of the usu
size fitted with a barrel, which the sext
turned to produce the tunes. No more th
seventeen years ago I found one at wo
in Essex, and persuaded the "organist"
give me a recital. When the organ was abse
the accompaniment came from a band
strings, wood-wind and brass played
amateurs—most of them working-men. Th
was the usual thing in rural places.

Hymns, in the Church of England,
essentially a Victorian growth; these we
practically unknown in public service at t
beginning of the reign. The Nonconformis
however, had used them for half a century, a
in many of their churches there was consid
able musical culture. On special da
oratorio selections were sung with full ba
and chorus. The Sacred Harmonic Soci
was an outcome of the musical enthusiasm
the Nonconformists. The Roman Catholics
course had always freely admitted music,
there was nothing special in their cultivati
of it at this period.

Examine the collections of psalm tunes, &
issued during the year. That new blossom
budding is evident by their number. Tu
books were issued by Cruse, Sale, Haw
Maybrick, Patten and Andrews, Saffe
Marcus, Haycroft, while Goss's Paroch
Psalmody went into its seventh edition. Cr
provides for metrical psalms only, either in
old or new version. He had intended to int
duce chants, but thought it not worth wh
Sale makes an earnest endeavour to sh
how the canticles should be chanted, by pri
ing them out at full length with the cha
repeated time after time, above the wor
He makes no reference to chanting the pr

psalms. Marcus gives 68 tunes for the psalms, unes for the five hymns at the end of the Prayer-book, one response and four single chants. Saffery gives tunes for the metrical psalms only. Hawes' work is more advanced. t was compiled to suit Dean Milman's hymn-book, and provides tunes for nearly 300 hymns. The tunes in these books are partly old, partly editorial, some strangely florid. The grace notes are unblushingly inserted. The general rule was always to add passing notes and scale runs where they could be got in. Adaptations from the great composers are ampant. Sale calls attention to the adaptaions he has made, as proof of his own modesty, and as an act of homage to Haydn, Beethoven, &c. How taste has changed! Though the printed books did not sanction it, here is ample testimony that the ancient custom of putting the melody of a tune in the enor, lingered. More than once I have heard men describe the skill of their mothers in extemporising a "counter" above the air, made up chiefly of the alto and tenor an octave above pitch.

As to the instruments of the time, ladies played pianoforte, harp, and guitar, but not he violin. On the other hand, the pianoforte was considered unmanly, and Oxford undergraduates hissed a male pianist off the platorm. Men played the German flute when hey played anything. The upright pianoforte, higher than our heads, with its fluted silk front, omes up to the memory. Of orchestral nstruments, the strings have not changed at all; the wood-wind slightly. The serpent, a bass member of the wood-wind group, now extinct, was still in use; the Guards' Band had them. The brass instruments have hanged most. Sax invented the pistons, made fingering uniform, and rendering the brass family easy to play, gave birth to brass bands. The cornopean, afterwards called the ornet, belongs to this time. In principle it is a saxhorn. Mechanicians were just now at work upon the free reed, and their work issued n the accordion or concertina, and the seraphine, afterwards developed into the harmonium and American organ.

I am afraid you will say that this gift of 1837 was a doubtful blessing. The blatant buzz of the free reed is still with us, and hough it is smothered in the American organ, musicians have never accepted it. Wheatstone's English concertina, brought out at this time, is a much more artistic kind of nstrument, but it has suffered unjustly because of its companions. Another new instrument, if it may so be called, was the contralto voice of the woman. Chorley says, writing in 1837, that until the last twenty years this voice had scarcely been heard in England, having been neglected for the sickly and unnatural male falsetto.

Another gift of the period, almost as valuable as the concertina. It was a year earlier (1836) that Rice, an actor at the Adelphi Theatre, in a play called "A Flight to America," personated a negro, and sang the song, "Jim Crow," with its rousing chorus, "Jump, Jim Crow!" The piece became the rage of the town: there were Jim Crow hats, coats, &c. The *Morning Chronicle* of December 11, 1837, announces as a great novelty, "the American Minstrels, self-taught men of colour from Philadelphia, in a series of morning concerts of national music." Thus began the Minstrel cult, which has shown remarkable persistence, so that after sixty years the banjo and the plantation song flourish more than ever.

What of popular music at this time? Did the people themselves sing? Of course they did, just as they laughed and talked, just as they sorrowed and joyed. Haynes Bailey's ballads, "I'd be a butterfly" and "O no, we never mention her," were whistled and hummed. Henry Russell's songs were floating over from America, where he then was; and there were songs of a rougher kind. At Christmas the waits were universal, and they went round with instruments as well as voices. Then there were ballad singers, men who sang and hawked their penny broadsides to the remotest hamlet. The street ballad flourished greatly at this time; within a few hours of any event of public interest, a song, set generally to an old tune, was ready for distribution. These songs are still issued; you may happen upon the street ballad singer in Connemara or Cornwall—to-day he will be singing of Jameson's ride.

As to street musicians it should be remembered that this was before the days of the brass band. The only account of London street music I have come across is in Fenimore Cooper's "English Sketches" issued this year. It is curiously favourable. "London street music," he says, "is the best in the world. Respectable artists walk the streets and play Rossini, Mozart, Beethoven, Meyerbeer, Weber, &c., beneath your windows. I have frequently paused in my evening walks to listen to airs that have come from harp, violin and flageolet, and have almost fancied myself in Venice or Naples, though surrounded by the dingy bricks of London."

The democratisation of music was at this time beginning. There was stirring in a few minds the idea that the whole people might be taught music, and thus brought within a humanising influence. The example of Prussia and Saxony was quoted, where every school child learnt to sing. From many directions the forces of enlightenment were gathering. The Government was moving. Schools were springing up. Charles Knight and his cheap publications were diffusing information. A desire for the popularisation of art naturally accompanied a desire for the popularisation of knowledge. "The period," says Knight, speaking of this time, "was then only beginning when an idea penetrated the English mind that in music, as in the other fine arts, anything but the commonplace and vulgar could have any charms for the bulk of the people." And he quotes Isaac Bickerstaff who, 120 years before, had remarked that an Englishman has so little inclination to music that he seldom begins to sing till he is drunk. So early as 1835 Lord Brougham, then Chancellor, in giving evidence before the House of Lords on education, had urged that the rudiments of vocal science should be taught in the national schools. The *Times* laughed at him, and asked if he expected to raise up a population of Brahams and Billingtons. The *Musical Magazine* of the same year, however, supported Lord Brougham, and prophesied a new order of feeling and sentiment as music took possession of the hearts of the young, a feeling which would qualify the excesses of mere untamed feeling. Knight's "Penny Magazine" (1834) urged that music should be made accessible to all, and that, as a mode of enlarging the cheap enjoyments of a poor man's life every village school in the kingdom should possess the means of teaching musical notation. Joseph Mainzer was at this time conducting his great singing classes for artisans in Paris, and they had already attracted attention. Chorley corresponded with him, and in his article in the *Westminster Review* for July, 1837, he prints a letter from Mainzer describing his work. Mainzer came to England in 1839 and lived and died here. In the early forties Hullah and Curwen began work, but this is later than our period.

A prophet of popular school music at this time was W. E. Hickson, a shoe merchant in Smithfield, Unitarian by faith, who devot himself for years to the service of the people this respect. In January, 1837, he was lectu ing at the Mechanics' Institute on "The intr duction of local music in schools as a bran of national education;" and later at t Royal Institution, at Willis's Rooms, and the Sunday School Union. Hickson w both philanthropist and philosopher. looked round the England of 1837, a found a population as rude in mann mind, and feeling as perhaps could be fou in any part of the civilised world. discovered a larger proportion of juven criminals than in any country of Europe. saw that some amount of pleasurable rela tion from labour was necessary to ev condition of animal existence. The questi therefore, was whether we should have high low recreation? Looking about for the b moral engines by which character can influenced, he found music, which chee the heart, and favoured the growth of kin and generous feelings. Music would make a bad man a good man, but there is man, he said, who would not have been bet for the influence of music. Hickson had meet the argument, that in proposing teach part-singing to the children of poor, he was educating them above th station, and leading them to habits dissipation. He was not content to ta He wrote words for children to sing to g music. Many of them are still sung, " again," "Bells ringing," "The might w the right," "The Chatterbox," and "God bl our native land." Under his direction ma school teachers of singing were trained, in his lectures the children sang his son How true his views were; how admirable spirit; how inspiring to those who are s working for the popularisation of our art!

DISCUSSION.

The CHAIRMAN moved a cordial vote of tha to Mr. Curwen for his extremely interes paper. Following the title, he had confined observations mainly to the state of music at time that Queen Victoria ascended the thr and they were all much indebted to him the research he had brought to bear on the sub and for the very interesting remarks he had upon it. Probably very few present realised be as they did at that moment, the actual cond of music at that particular period, but it npossible to listen to Mr. Curwen's suggestive bservations without allowing their minds to come little nearer to the present time, and without sking themselves what had been done in the ray of music in England since that date. It could ot be doubted that an enormous advance had ıken place since the Queen ascended the throne. 'his most memorable year, of her reign was one 'hich justified them in looking back and recalling er own great influence on all that appertained to the romotion of civilisation and education, and the elfare of her people; and, in doing so, they could ɔt on that occasion fail to notice the great progress hich had taken place in music during this most emorable reign. It might be that foreign music had tracted more attention in this country than the music our own composers, but music was a universal nguage, it knew nothing of frontiers, or of those contions which hampered written and spoken language. he music written in England, France, Germany, Italy, any other part of the world, was readable and comehensible to any musician who saw it. It might that those who took up a piece of music written in foreign country might not even be able to read the le, but the music itself was intelligible, as it spoke a universal language. If, therefore, anything good ıs produced abroad, we, who were not jealous or vious of the success of other countries, welcomed ıt music to London, which after all was the headarters of music, as it was of every other art. e could not doubt either that English music s beginning to make its way on the continent o. It might be that we in this country ll preferred the music that came from abroad, l he could not blame anyone for admiring creations of the great composers on the Conent; but we had in England composers who were rthy of attention also, and it was a comfortable l proud thought to believe that their genius was ginning to be recognised on the Continent also.

he vote of thanks was carried unanimously, and meeting adjourned.

Miscellaneous.

THE CULTIVATION OF CHICLE, OR CHEWING GUM, IN MEXICO.

hicle chewing gum is principally extracted from chico-zapote, the *chic-zaptl* of the Tarascans. er plants are also chicle producing, such as *Amate*, wing wild in the district of Jalpa, Tabasco; *mito*, cultivated and found wild in the district of a, in the municipalities of Cunduacan and denas, Tabasco, and in the canton of Jalapa, Cruz; *Cajou de mico*, found wild in the municiy of Macuspana, Tabasco, and in the departt of Comitan Chiapas; *Copo*, found wild in the municipality of Frontera, Tabasco; *Ghichixisha* and *Matapalo*, found wild in the municipality of Zanatepec, Oaxaca; and *Sictillo* or *Yoyote*, indigenous to the districts of Cunduacan, Nacajuca, and Huimanguillo, Tabasco. Sir Henry Dering, H.M. Minister at Mexico, in a further report upon the vegetable products of Mexico, says that chico-xapote (*Acheas sapota* of Linnæus) is the most abundant and important of these gum-producing trees. This tree is found in many districts, and it is cultivated in the districts of Choapam, Cincatlan, and in the municipality of Zanatepec, Oaxaca; in the districts of San Juan Bantista, Jalapa, Cunduacan, Cardenas, Nacayuca, and Huimanquillo, Tabasco; in the districts of Jalapa, Cordoba, Minatillan, Vera Cruz; and in parts of Morelos and Michoacan. Chicozapote belongs to the family of *Sapotaceæ*, and two kinds, the red and white, have been found in the dense forests of the above mentioned regions. The white zapote produces more gum than the red kind —as high as 6 lbs. to the tree—and the white is generally taller, being 12 metres in height, whilst the red zapote has a thicker bark from 8 to 10 metres high, and seldom yields more than 3 to 4 lbs. of chicle. The leaves of both trees are somewhat elliptical, and on young branches or shoots they are rather numerous. The fruit is spherical, sometimes 2 and 3 inches long; its edible matter is white, and tastes like the pear, and the seeds are two or three in number, of a dark brown colour, flat, and irregular in shape. A warm, moist climate is necessary for the successful growth of the tree if large amounts of fluid are expected. Higher than latitude 22° N. it will not grow at all, and north of Vera Cruz city it will not do well in the mountains above 2,000 feet. However, south of 19° N. latitude it is cultivated at altitudes as high as 3,500 and 4,000 feet above sea level, yet it will thrive best at elevations between 150 and 1,200 feet even in these latter regions. The best soil adapted for its cultivation is that occurring in valleys and undulating lands along the river meadows at the foot of the mountains. In the Tuxpam and Papantla valleys, especially in the dales adjoining the Pantepec, Cazones (San Marcos), and Tecoluta rivers, splendid lands suitable for its cultivation can be found. The zapote can be propagated from cuttings, suckers, and layering, but the tree grows readily from the seed, and that system has been adopted by those who plant it. Nursery beds are prepared in the usual manner in a half shaded space close to a stream. The seeds are sown in October and November, and sometimes in July. When the seedlings are 18 to 24 inches high they must be transplanted. As the tree is a hardy one, the expenses of keeping the zapote plantation clean are small. One or two light weedings a year is all that is necessary. At the fourth or fifth year after transplanting the tree it may be tapped, but it is best to wait until the sixth or seventh year, or when they are 12 to 15 inches in diameter, wherein better results may be obtained. The tree

lasts over 100 years, and then, or before, its fine wood can be utilised for the manufacture of first-class furniture, or for durable timber. The gum is produced from the leaves, fruit, and bark of the tree. From the fruit it is extracted in the months of March and April, before the fruit becomes ripe. When gathering the fruit, the stem is allowed to remain on it, but subsequently taken off to admit of the juice running out. This is collected in a shallow vessel, allowed to solidify, washed in warm water to collect and clean it, and then boiled down to evaporate the water, set aside to cool, and lastly formed into blocks to be marketed. Three thousand two hundred zapote pears produce one pound of gum. The fruit is also sold for about 1 cent. apiece in Vera Cruz, Puebla, Oascaca, Orizaba, Mexico, Guadalajara, and other large cities, and has recently been exported to the United States. In September and October the gum is extracted from the leaves. The process is the same as that of the fruit, and the yield alike. After the rainy season is over, generally in October, the trees are tapped once every year. The custom of the natives, the *chicleros*, is to get up the tree, to a distance of about 46 feet, make three diagonal cuts by a double oblique blow of the *machete* on either side of the tree, and have the wounds join at their lower ends. A shallow tin vessel is tied on to the tree below the wounds to collect the juice. Then the operator leaves this tree and taps another. He performs this operation in twenty minutes, and it takes three-quarters of an hour for the tree to bleed itself. One man will tap from twelve to sixteen trees per day, each producing from 3 to 6 lbs. of juice. This is collected in gourds holding 12 pints, and heated on an iron pot until it boils up, when it is stirred with a stick quickly and continually until the foaming gum subsides, and has been reduced to half. When cool it is washed in water, and formed into blocks, *marquetas*, of 2, 4, 6 and 12½ lbs. Sir H. Dering says that the present system of tapping could be improved, and that the juice should be strained before being boiled down. The expense of a plantation of 100 acres to the time of production (six years after transplanting) is as follows:—Clearing the land, from 600 to 800 dollars; nursery, 250 dollars; planting, 600 dollars; weeding (six years) 1,200 dollars, and fencing, 50 dollars. At an additional expense of 10 per cent. a patch of Indian corn can be raised, and the proceeds from it will more than meet the expense of the plantation. In the Tuxpam valley it costs from 5 dollars to 7 dollars per *arroba* of 25 lbs. to gather and clear the gum—that is, by contracting the work with the experts (the *chicleros*); but by hired labour there and in Papantla, Misantla, Esperiol and Zamovra Gutierrez the cost will only be from 10 cents. to 15 cents. per pound. In Campeche and Michoacan the cost is as high as 20 cents. per pound, and in parts of Oaxaea, Vera Cruz, and Tabasco, from 4 to 25 cents. a year per tree is paid for the privilege of tapping trees on private lands. The
production of chicle for the year 1892, the latest fo
which the particulars are available, was as follows:—
In the district of Carmen, Campeche, 1,380,74
kilogrammes, valued at 12,000 dollars; in Oaxaca
the districts of Juquila and Tuxtepec reported 1,15
kilogrammes each, valued at 950 dollars; in Puebla
the district of Huauchinanys produced 1,200 kilo
grammes, valued at 600 dollars; in Tabasco, th
district of Balancan, yielded 16,108 kilogramme
valued at 11,200 dollars; and the municipalities
Zamora, Gutierrez and Tecolutu, Vera Cruz, reporte
3,445,434 kilogrammes, valued at 1,824,000 dollar
Sir Henry Dering says that the price of chicl
chewing gum at New York city was at the date
his report (July 18 last), 45 cents gold per pound.

THE ALGERIAN WINE INDUSTRY.

After several years of great depression, the pr
duce of Algerian vineyards during 1895 has bee
once again most satisfactory. The wine sold rapid
and well, leaving a profit it is said in the hands of t
producers of not less than 50,000,000 fran
(£2,000,000 sterling). Sir R. Lambert Playfair, H
Majesty's Consul at Algiers, in his last report refe
to a *brochure* on the subject of Algerian wines, o
of the admirable series lately published by t
Government of Algeria, with a view to bringing t
resources of the colony prominently to the notice
the public in France and foreign countries. T
great impetus given to the cultivation of the vine
Algeria commenced about twelve years ago, owing
the destruction of the plant in France from t
phylloxera. The climate and the soil of the colo
are admirably suited to the cultivation of the vi
At the present time, 100,000 hectares (hectare
2·47 acres) are now in full bearing, and capable
producing from 3,500,000 to 4,000,000 hectolitres
wine (hectolitre = 22 imperial gallons). The amou
of wine consumed in the colony by the Europe
population, numbering about 420,000 persons, m
be estimated at 1,000,000 hectolitres; the remaind
from 2,500,000 to 3,000,000 hectolitres, is export
almost entirely to France. The vine plantati
occupy a zone of about 1,200 kilometres in len
along the sea-coast, with a breadth of about 1
kilometres towards the interior. This immense s
face comprises the most diverse soils, and gr
differences of altitude and of exposure, and
matter what may be the nature of the clim
of the region to which the plant is exposed,
the quality which is cultivated, no matter w
the means of vinification which are employed,
product when exported is only known under
name of "Algerian wine." No distinction is m
between the wine produced on the moun
sides or in the plains of the littoral. The resul
that under this generic denomination the most hete
geneous products are found in commerce, having
resemblance one to the other, and not being susc

tible of comparison. This unfortunate custom has naturally had a very pernicious influence on Algerian wines, and produced most contradictory opinions relative to its value. Moreover, during the period when fabrication of wine flourished, the manufacturers of it offered for sale great quantities of so-called "Algerian wine" of more than doubtful origin. At he commencement of the industry vignerons from ll parts of France brought with them the plants f their native districts; the forest vines of the ironde were planted in proximity with those of urgundy. With the exception of a few native arieties, the greater part of the Algerian vineyards re planted with vines from the south of France and pain. Amongst the red varieties the most common are he Carignan, the Mourvèdre or Espar, the Alicante r Grenache, the Morastel, the Œillade, the Cinsault, c. The Aramon is also cultivated in Algeria, but yields less abundantly than it does in the South of rance, though the wine is more alcoholic and fresher. t is preferred for consumption in the colony rather han for exportation. The plants whose fruit is highly loured, like the Petit Bouschet, also enters into the mposition of Algerian vineyards; this wine is darker, nd on that account is esteemed in France for mixing ith wine which is naturally too pale. The vines sed for making white wine are the Clairette, the gni-blanc, and two native varieties, the Aïn-Kebb nd the Ferana. The wines of Algeria are generally rong and of deep colour, qualities due to the heat the African sun, but they are deficient in the quisite delicacy of those of Bordeaux and Bour- gne, which are produced in a more temperate imate. In the department of Algiers, which differs eatly from either Constantine or Oran, the vine- oducing region may be divided into three zones—) The zone of the Sahel. This includes the hilly gion which stretches westward from Algiers to erchel, and which is limited to the south by the ains of the Metidja. To this may be added the untry from Cape Matefou eastward as far as Oued- ser, containing the much esteemed vineyards of in Taya, Menerville, and Courbet. The wine of is region is deep red and highly alcoholic. It is the most part consumed in the country. (2) The ne of the littoral. Very similar to the vineyards of e Sahel are those of the hills along the coast from erchel westwards, and from the Oued-Isser to the stern limit of the department. Here the soil is of cretaceous formation, and similar to the principal ain of the Atlas. (3) The zone of the plains. e Metidja is the most important centre of produc- n. The wine of this region is generally less oholic than that of the Sahel, frequently of a ler colour, and with a distinct earthy flavour. e last character, however, disappears when e is taken to separate it as soon as possible m the must. The white wines produced here of good quality and much sought after. The st wines in the department of Algiers are those duced at the greatest altitudes. The principal centres of production are Médéa, Damietto, and Lodi. Ain Bessem, where the vines are still young, will, it is said, probably prove equal to the foregoing, and the wine of Miliana is considered as about the best in the colony. The quantity of wine exported from the department of Algiers amounted in 1894 to 1,043,000 hectolitres (22,946,000 gallons). The department of Oran, situated to the west of Algiers, has a climate hotter and drier than that of the two others. The plants especially cultivated are those of the south of France and of Spain, the Carignan, Morastel, Espar or Mourvédre, and the Alicante or Grenache. In certain localities such as Marcara, Ilemçen, and Sidi Bel Abbes, native localities enter, to some extent, into the constitution of vineyards. As a general rule it may be stated that wine produced here sells in commerce from two to three francs per hectolitre less than that of Algiers. The wines of the interior region have a marked superiority over those of the littoral. The wine exported from Oran in 1894 amonnted to 810,000 hectolitres (17,820,000 gallons). In the department of Constantine the vine-producing districts, as in the other departments, may be divided into two groups, the littoral and the interior. The vines grow well everywhere, but are more subject to cryptogamic diseases than in Algiers or Oran, perhaps owing to the fact that the prevailing winds are more highly charged with humidity. The exportation of wine from the two ports of Constantine in 1894 was as follows:—Bône, 228,560 hectolitres (5,028,000 gallons); and Philippeville, 228,375 hectolitres (5,024,000 gallons). The lately imposed tax on alcohol is likely to have an adverse influence on Algerian viticulture. The Finance Law of December 28 established a duty of 75 francs per hectolitre on all alcohol imported into or manufactured in the country, instead of one of 30 francs which had hitherto existed. This has caused great excitement amongst the colonists, and numerous protests have been made against the measure.

Correspondence.

SLAVERY IN NORTHERN INDIA.

I have looked over the Reports of 1841 regarding slavery in India, to which Mr. Lee-Warner referred his audience for further information on the subject of his paper, with the view of ascertaining how far, and in what forms, slavery is reported to have been prevailing in Northern India before the passing of the Act to declare and amend the law regarding slavery in 1843. It will be understood that in this note, as in the remarks made by me during the discussion that followed Mr. Lee-Warner's paper, I am speaking only of Northern India.

The following extracts are made from the replies submitted by the civil officers to queries addressed to them, as they are given in the Report from the

Indian Law Commissioners, page 56. Agra Magistrate:—"In this part of Upper India, Hindu or Mahommedan slavery can hardly be said to exist. In the district of Agra there is not, I believe, one lawful slave. Of course, during famines, and even under the pressure of ordinary poverty, parties are in the habit of selling their children to those who can provide for them." He goes on to show that by Mahommedan law the sale of free children is quite illegal.

Page 74. Delhi Territory.—The Commissioners say:—"It appears from the reports of the public officers that the right of a master over a slave or his property has not been acknowledged either in the civil or the criminal courts of this territory for a number of years."

Page 329. Reply of the Chief Civil and Criminal Court (1836):—"The criminal courts practically acknowledge no legal right in the master over either the person or property of his slave . . . their ordinary practice is to refer the parties to the civil courts for redress. The civil courts recognise in practice the claim of the master to the possession and services of his slave, and his legal right to dispose of him. A slave can possess no property in his own right. No distinction is drawn, however, between slave and free men in criminal matters; or between slave and master; the courts afford them equal redress. No assistance is given to recover absconding slaves." Generally, the Court say:—"Throughout the western provinces slavery, in the legal acceptation of the term, exists in a very limited extent, and in several of the districts it is scarcely known at all, while all authorities, civil and criminal, unite in bearing testimony to the mildness of the form where it still prevails, and to the generally happy and comfortable condition of the slaves in those places being little inferior to that of menial servants. Indeed, in some parts of the country the relationship between them and their masters is described as resembling that of parent and child."

It appears, moreover, from the particular reports of the civil officers, that civil suits to enforce rights over slaves were exceedingly rare.

Page 335. Civil Judge of Goruckpore, a very large district, writes (1836):—"On enquiry I cannot discover that the practice of slavery in any form has ever existed in this district. After strict search in the records, I can only find one suit for the recovery of a slave girl, and that was dismissed."

The replies of all the civil judges are to the same effect, or nearly so. Most of them say that they never heard of civil suits for rights over slaves; and all agree that in the criminal courts a slave is treated precisely like a free man. The letter of Mr. Neave, Judge of Cawnpore (p. 344-5), should be read *in extenso.* "On the whole," he concludes, "it seems there is little reality in the slavery of India, and that it is, with the exception of one description, more in name than in reality." The one exception probably refers to the buying and keeping of girls either as prostitutes or for concubinage, and this exists, as a clandestine practice, at the present day.

The Magistrate of Saharanpore, another very large district, writes, page 355:—"In this zillah slavery is unknown, or if existing, is so concealed or exists to such a trifling extent, that in my personal experience I have never met with a case." The Magistrate of Meerut, a very important centre, writes (page 357) quite as positively.

In their observations (page 193), the Law Commissioners refer to "the lawful and nearly innocuous status of slavery in India," and evidently doub whether it is worth abolishing, if it can be kep within its existing limits.

And at pages 30-31 of their final report, th Commissioners give their conclusions as to th treatment and condition of slaves. The citation from the replies of North-West Province officer show that, in those provinces, slavery was hardl known, and was very mild indeed where it survivec and that both importation of slaves and traffic wer prohibited.

It must be remembered that, in Bengal, a regulatio had been passed in 1811, strictly forbidding the im portation of slaves into British India, and traffic i them within our territories. And in 1832 anoth regulation enacted that all slaves imported int British India after 1811 were free. The Act 1843 was, as its title shows, a Declaratory Ac intended to make the law quite clear, and to exter it in some respects. But it cannot be accurate described, at any rate, for Northern India, as "tl great achievement of the abolition of slavery 1843."* So far as concerns the history of Nor India, this Act is not of the nature of an epoc making statute, nor am I disposed to be great surprised that historians have taken little notice of Legal slavery must have been nearly extinct before t Act was passed, and its principal effect must have be to relieve our civil courts of doubts and difficulties regard to the rare cases that occasionally came befc them. All suits or processes to enforce slavery rigl in a court were definitely barred; but in other respe the Act seems merely to have given distinct sancti to established principles and procedure.

Mr. Lee-Warner has probably good grounds his statement (page 164) that "during the famine 1813, in the Agra district, half the free populati disappeared." But I have not the reference; is it clear whether he really means, as the cont seems to indicate, that they became slaves. Unl this is his meaning the citation is hardly relevant. T only other direct reference to North India that I find in the lecture is a statement on page 165, tha Agra, in 1813, a boy was sold by his parents fo single meal; but this by no means implies necessa that he was sold into slavery.

I, therefore, desire it to be understood tha deliberately maintain the view which I expressed i

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* Mr. Lee-Warner's paper, p. 164, Society of Arts *Jour.*

brief and unprepared observations, regarding the
stence of true slavery in North India to the extent
resented in Mr. Lee-Warner's paper.

A. C. LYALL.

th March, 1897.

Obituary.

AMES JOSEPH SYLVESTER, D.C.L., F.R.S.—The
inguished mathematician, Professor Sylvester, who
d on Monday, 15th inst., in his 83rd year, was
aminer in Algebra for the Society of Arts from 1861
1869, which was the last examination in this
ject, as the science examinations were then dis-
tinued. At this time he was Professor of Mathe-
tics at the Royal Military Academy, Woolwich.
early life he was Professor of Mathematics at the
iversity of Virginia, and in 1877 he again returned
he United States on the foundation of the Johns
pkins University, Baltimore, when he became the
Professor of Mathematics. In 1880 he suc-
ded the late Professor Henry Smith as Savilian
fessor of Pure Geometry in Oxford. He received
oyal Medal of the Royal Society in 1860 and
Copley Medal in 1880, also the De Morgan
dal of the London Mathematical Society in 1887.
December 12, 1885, he made known his newly
overed Theory of Reciprocants in an inaugural
ure delivered before the University of Oxford.
ides the large number of mathematical memoirs
lished in the chief English and foreign journals
transactions, Professor Sylvester was the author
volume on the "Laws of Verse."

General Notes.

HE SWISS EXHIBITION OF 1896.—The Swiss
ional Exhibition, which was held at Geneva
the 1st of May to the 18th of October
was conducted at a great financial loss. The
ederation subscribed one million francs, and the
and canton of Geneva provided a guarantee fund
00,000 francs. In addition, the Exhibition Com-
y issued 500,000 francs in stock, which was sub-
ed to by various patriotic citizens. All this has
swallowed up, and there was an estimated
cit of from 100,000 to 300,000 francs, which it was
ed would be covered by the profits of a national
ery. According to Consul Ridgely of Geneva,
financial failure of the exhibition was due entirely
he exceptionally bad weather. The exhibition
inaugurated in a storm of wind and rain on the
of May, and was closed on the 18th of October
nded by the same unfavouring elements. During
entire season there were only a few days of good
ther, and the whole country became in consequence more or less dispirited. Thus it happened that Switzerland's greatest national industrial enterprise was a signal financial failure. In all other particulars, however, it was a splendid success. The displays were thoroughly representative of the mechanical industry, as well as of the agriculture and art of the country, and were made on a scale of lavishness that would have done credit to a much larger and richer nation.

RECEIPTS OF PARIS THEATRES IN 1896.—A return has recently been issued by the French authorities, showing the gross receipts of the principal theatres and places of amusement in Paris, during the year 1896. The general total amounts to £1,202,852, as compared with £1,186,400 in 1895, and £1,170,300 in 1894. Taking the amounts received at each establishment, it will be found that the Opera, as usual, heads the list with a revenue of £128,000 (£126,000 in 1895). Then comes the Comédie Française with £86,407, and the Opera Comique with £60,623. The amounts realised by these two theatres in 1895, amounted respectively to £83,000 and £57,800. The Folies Bergères realised £51,428; the Porte St. Martin, £47,768; the Châtelet, £46,776; the Vaudeville, £43,680; the Renaissance, £40,745; the Gaieté, £39,200; the Scala, £37,100; the Gymnase, £36,300; the Ambiqu, £32,000; the Nouveau Cirque, £25,600; the Casino de Paris, £25,500. The receipts from the Moulin Rouge were £20,300; from the Cirque d' Hiver, £16,300; while those from the Olympia amounted to £27,000.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

MARCH 24.—"The Transmission of Power by Alternating Electric Currents." By W. B. ESSON, M.Inst.C.E. ALEXANDER SIEMENS, Member of Council, will preside.

MARCH 31.—"Cycling—Historical and Practical." By GEORGE LACY HILLIER.

APRIL 7.—"Dairy Produce and Milk Supply." By M. J. DUNSTAN, M.A., F.R.S.E. The RIGHT HON. LORD BELPER will preside.

Papers for meetings after Easter.

"London Water Supply." By PERCY F. FRANKLAND, Ph.D., F.R.S.

"Silver and Prices: the Economic drain of Debtor Nations." By MORETON FREWEN, B.A.

"Children's Sight." By R. BRUDENELL CARTER, F.R.C.S.

"Fireproof Construction." By THOMAS POTTER.

"Motor Traffic: Technical Considerations." By Sir DAVID SALOMONS, Bart.

INDIAN SECTION.

MARCH 25, at 8 p.m.—"The Cultivation and Manufacture of Rhea Fibre." By THOMAS BARRAclough. Sir William Henry Houldsworth, Bart., M.P., will preside.

April 1, at 4.30 p.m.—"A Visit to Russian Central Asia." By Michael Francis O'Dwyer, I.C.S. (Assistant Commissioner in the Punjab).

May 6, at 4.30 p.m. — "Kafiristan: its Manners and Customs." By Sir George Scott Robertson, K.C.S.I. (late British Agent at Chitral). Field-Marshal Lord Roberts, V.C., G.C.B., G.C.S.I., G.C.I.E., will preside.

May 20, at 4.30 p.m.—"India and its Commerce." By Sir James Lyle Mackay, K.C.I.E. (late President of the Bengal Chamber of Commerce).

The meetings of April 1, and May 6 and 20 will be held at the Society of Arts; and that of March 25 at the Imperial Institute.

Applied Art Section.

Tuesday Evenings, at Eight o'clock:—

March 30.—"Lead-work." By W. R. Lethaby.

April 27.—"Delft Ware." By Dr. J. W. L. Glaisher, F.R.S.

May 11.—"A Half Century of Line Engraving, 1780-1830." By George Clulow.

Cantor Lectures.

Monday Evenings, at half-past 4 o'clock:—

Prof. W. Chandler Roberts-Austen, C.B., F.R.S., "Alloys." Four Lectures.

Lecture II.—March 22.—The diffusion of liquid and solid metals.

Lecture III.—March 29.—Steel and cast-iron, considered as carbon—Iron alloys.

Lecture IV.—April 5.—Advances in our knowledge of alloys since the last course of Cantor Lectures "on Alloys" was delivered, in 1893.

Lewis Foreman Day, "Design in Lettering." Four Lectures.

May 3, 10, 17, 24.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 22...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Cantor Lectures.) Prof. W. Chandler Roberts-Austen, "Alloys." (Lecture II.)

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. Mr. John Laing, "Milk and Butter from a Hygienic, Pathological, and Manufacturing point of view."

Imperial Institute, South Kensington, S.W., 8½ p.m. Dr. W. Schlich, "The Timber Supply of the British Empire."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. C. H. Hooper, "Fruit Growing as an Auxiliary to Agriculture."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Sir Clements Markham, "The North Polar Problem."

Actuaries, Staples-inn-hall, Holborn, E.C., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. W. Wethered, "A Run through Portugal and Maderia to the Great River Amazon."

Medical, 11, Chandos-street, W., 8½ p.m.

Sanitary Institute, 74A, Margaret-street, W., 8 p
Prof. W. H. Corfield, "Water Supply, Drink
Water, Pollutions of Water."

Tuesday, March 23....Royal Institution, Albemarle-str
W., 3 p.m. Prof. A. D. Waller, "Animal El
tricity." (Lecture X.)

Medical and Chirurgical, 20, Hanover-square,
8½ p.m.

Civil Engineers, 25, Great George-street, S.
8 p.m. Discussion on Mr. H. A. Humphr
Paper, "The Mond Gas-Producer Plant and
Application."

Photographic, 12, Hanover-square, W., 8 p.m.
A. M. Brice, "Polar Exploration."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Wednesday, March 24...SOCIETY OF ARTS, John-str
Adelphi, W.C., 8 p.m. Mr. W. B. Esson, "
Transmission of Power by Alternating Elec
Currents."

Geological, Burlington-house, W., 8 p.m.

Sanitary Institute, 74A, Margaret-street, W., 5
Civil Engineers, 25, Great George-street, S.W., 4
Dr. G. Sims Woodhead will repeat the
"James Forrest" Lecture on "Bacteriology.'

Royal Society of Literature, 20, Hanover-square,
1 p.m.

Patent Agents, 19, Southampton-buildings, W
7½ p.m. 1. Discussion of Mr. A. P. Jones's Pa
"Some Notes on a Bill relating to Trade Ma
prepared by the London Chamber of Commer
2. Mr. A. V. Newton, "The Extension of Expi
Patents and Suggestions for Amending the Prac
of the Judicial Committee of the Privy Counci
relation thereto."

Thursday, March 25...SOCIETY OF ARTS, John-str
Adelphi, W.C., 8 p.m. (Indian Section, at
Imperial Institute.) Mr. Thomas Barraclo
"The Cultivation and Manufacture of
Fibre."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, W., 8 p.m. Prof.
Frankland, "The Pasteur Memorial."

Society for the Encouragement of Fine Art
Conduit-street, W., 8 p.m. Mr. G. C. H
"Design and Designers during Her Maje
Reign."

Royal Institution, Albemarle-street, W., 3
Prof. W. Boyd Dawkins, "The Relation of
logy to History." (Lecture I.)

Electrical Engineers, 25, Great George-street, S
8 p.m. Discussion of Mr. H. Benest's Pa
"Some Repairs to the South American Compa
Cable off Cape Verde 1893 and 1895."

Camera Club, Charing-cross-road, W.C., 8¼
Mr. L. Howie, "From Mount Blanc to
Matterhorn."

Friday, March 26...Royal Institution, Albemarle-street,
8 p.m. Weekly Meeting. 9 p.m. Sir Wil
Turner, "Early Man in Scotland."

Civil Engineers, 25, Great George Street, S
8 p.m. (Students' Meeting). Mr. W. J. Grif
"The Re-signalling of the Liverpool Street
minus of the Great Eastern Railway."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burling
house, W., 5 p.m.

Saturday, March 27...Botanic, Inner Circle, Regent's-
N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3
Lord Rayleigh, "Electricity and Electrical
brations." (Lecture IV.)

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FRIDAY, MARCH 26, 1897.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

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CANTOR LECTURES.

The second lecture of the course on 'Alloys,'' was delivered by Professor W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., n Monday afternoon, 22nd inst.

The lectures will be printed in the *Journal* uring the summer recess.

CONGRESS ON TECHNICAL EDUCATION.

The Congrès International de l'Enseignement Technique has accepted an invitation om the Society of Arts, and certain of the ity Guilds, to hold its meeting this year in ondon, commencing on the 15th of June next. he previous meetings of the Congress were—n 1886 at Bordeaux, in 1889 at Paris, and in 895 at Bordeaux. The following companies ave provided the funds required for the Conress:—The Drapers' Company, the Fishmongers' Company, the Goldsmiths' Company, he Merchant Taylors' Company, and the lothworkers' Company.

Further information as to the organisation the Congress will be published in due ourse.

VICTORIA RESEARCH FUND.

The following communication has been ceived from Lord Lister, the President of he Royal Society:—

"Burlington-house, Piccadilly,
"London, W.,
"February 22, 1897.

"SIR,—Upon the invitation of the President and ouncil of the Royal Society, the Presidents of scientific cieties in London met the President and Officers of e Society on February 9th to consider whether any, d, if so, what steps should be taken on the part of en of science to commemorate the present 60th year the reign of Her Gracious Majesty the Queen, a riod so rich in scientific discoveries. At that meeting, which was a very representative one, it was unanimously resolved:—

> 'That a Fund, to be called The Victoria Research Fund, be established, to be administered by representatives of the various scientific Societies, for the encouragement of research in all branches of science.'

"To raise a Fund of such a kind worthy of the occasion, the active co-operation of all the scientific societies of the Empire is imperatively necessary; for the Fund, to be so worthy, must be a very large one.

"It is not to be expected that scientific societies would in general contribute out of their corporate funds, though some might be willing to do so; but rather that the several societies should exert themselves to collect subscriptions to the Fund.

"Nor is it to be expected that men of science would themselves furnish the required sum. It is to be hoped that they would contribute so far as each felt able. But the chief gifts are to be looked for from the public, from those who are not themselves engaged in scientific inquiry, and especially perhaps from those whose wealth has been the direct or indirect result of the scientific progress of the Victorian era.

"So many demands are at the present moment being made in so many ways upon the purse for the purpose of commemorating the present year, that it may be worth while to point out that, the object of the proposed Victoria Fund being a lasting one, it is not necessary that the whole Fund should be raised at once. The Fund once established might be increased by subsequent additions, and contributions might be spread over many years, or might not be called in until some future time, so that the burden in the present year might be lightened.

"It is proposed that the income of the Victoria Fund should be applied to the advancement of all branches of science in all parts of the British Empire. Should therefore the project of the Fund be approved, and the Fund established, its administration will necessitate an organisation, the details of which will need most careful consideration in order that the Fund may be used in the best way in all future times; but such details may be left for the present.

"Meanwhile, the first step to be taken is to ascertain whether the proposal meets with such general acceptance among men of science as to justify the President and Council in proceeding further in the matter.

"I have therefore been requested by my Council to ask you to be so good as to bring the subject before your Society at your earliest convenience, in order to ascertain whether the proposal is approved or not, and at the same time to give the Royal Society the benefit of the advice of your Society upon the whole matter.

"I am, faithfully yours,
"(Signed) "LISTER,
"President of the Royal Society."

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, March 16, 1897; Sir FREDERICK YOUNG, K.C.M.G., in the chair.

The CHAIRMAN, in introducing Mr. Bonwick, said no one was more capable of treating the subject of his paper satisfactorily. He emigrated to Australia in 1841, had been eight years in Tasmania, five years in South Australia, 20 years in Victoria, and had travelled extensively through New South Wales and Queensland. He had been engaged in scholastic work during his residence in Australia, and was the author of a large number of works dealing with the history, geography, and trading resources of those colonies. During the last nine years he had been engaged as archivist by the New South Wales Government in the preparation of materials for a history of that colony, of which six volumes had already been published.

The paper read was—

THE PROGRESS OF THE BRITISH COLONIES OF AUSTRALASIA DURING THE SIXTY YEARS OF HER MAJESTY'S REIGN.

By JAMES BONWICK.

The Accession of Her Majesty was not known in Australasia, in the pre-telegraphic days, till three months after date. On October 27th, 1837, the following Government Order appeared in the *Sydney Gazette*; signed by the Governor and 150 others, saying, they

"Do now hereby with one full voice and concert of tongue and heart, Publish and Proclaim that the High and Mighty Princess Alexandrina Victoria, is now, by the death of our late Sovereign, of happy and glorious memory, become our only lawful and rightful Liege Lady Victoria, by the Grace of God, Queen of the United Kingdom of Great Britain and Ireland, Defender of the Faith, Supreme Lady of the Territory of New South Wales and its Dependencies, to whom we do acknowledge all Faith and Constant Obedience, with all hearty and humble affection, beseeching God, by whom Kings and Queens do Reign, to bless the Royal Princess Victoria, with long and happy years to reign over us."

This was the voice of all Australasia at that period; for New Zealand, Victoria, and Queensland were then under the Sydney Governor, South Australia had only a few hundreds of newly arrived settlers, and Western Australia existed feebly but in name.

The progression of Australasia has been *Material*, *Political*, and *Educational*.

The *Material progress* has been evidenced in the spread of settlement, the development of resources, the growth of wealth. Even the burden of public debt has a set off in solid and permanent property. In 1837, the weak colonies had no past, but in savagedom, had still many natural difficulties to surmount, with dark clouds obscuring the horizon; but the settlers, with British pluck and energy, were fully resolved, under the smile of their Virgin Queen, to do and dare.

The people knew that they were, as then believed, in a nearly resourceless region, only excepting soil and climate. The native inhabitants had produced nothing. While easy now to tread the path levelled by sixty years of toil, let us honour the memory of Australasian pioneers.

The Aborigines were a sore trial up to, and beyond, 1837. British Government was not unmindful of their interests, and officially pleaded for their kind treatment. Colonial rulers ever sought, by proclamation, to protect the weak forester, while defending the white victims of outrages. The new comers were not selected from the models of propriety; nor were they the timid and gentle who dared a long voyage, and faced primitive hardships.

The struggle has not quite ceased in 1897. Numerous tribes have sunk under vice, disease, battle and drink, while a mysterious depression from contact with a superior race is still sweeping others away. The wooden spear warriors retired to sulk and die. All the Tasmanians have gone. The more vigorous Maories have yielded to the pressure, and are not a tithe of their fathers' numbers. No; the sixty years of this reign have been no blessing to the *dark skins*.

The population of whites are the workers for material progress. The sea, the soil, the rocks are the sources of wealth. The sea still gives provision for the table. The soil yields grass for stock, timber for service, grain and fruit for food. The rocks are stores of building material and minerals.

The pastoral and agricultural growth of Australasia has been great.

It was in 1837 that squatters had their charter of freedom. Before that they were but trespassers on Crown lands. The Act of 1837, passed mainly because of intruders on Port Phillip pastures, admitted the right to graze on public lands, on the payment of rent and the possession of a Government license. But it was the "Orders in Council" of 1847 that established their security as Lords of the Wastes. Responsible rule in 1855 gave power for local parliaments to control unoccupied lands, though it was not till 1861 that the Free Selection System was adopted.

The various colonies had their own way of dealing with lands. While anxious to preserve areas for real and lasting settlement in agriculture, it was deemed necessary to afford scope to the raisers of wool and meat. The sheep alone now amount to 130,000,000.

Agricultural progress has been relatively greater than even the pastoral.

In 1837 the articles produced were nothing more than breadstuffs, vegetables and fruits, with small vineyards for a very limited wine manufacture. By 1897, other useful objects have been raised, including many thousands of acres in sugar-cane, besides valuable economic plants. The dairy system, under legislative action, has developed a profitable export to Europe, along with frozen meats, colonial wines and preserved fruits.

The fauna and flora of Australasia have aided in material progress. Without naming naturalists of primitive days, as Solander, Brown, &c., we recognise, since the accession, the labours of such men as Buller, McCoy, W. B. Clarke, Hooker, Strzlecki, Hochstetter, Tenison-Woods, Dieffenbach, Moore, Bennet, Haast, Hill, Bailey, Leichhardt, and Von Muëller. We have studied to utilise our continental and island trees and plants. We are busy in re-foresting as well as in acclimatisation. Our colonial Botanic Gardens are as useful as they are attractive.

Time forbids of detailing the more marvellous story of our geological progress, so interesting a field of research, the Aladdin's lamp of moderns, the touch of which reveals the precious things of dark earth and rigid rock. But, while esteeming the good work of scientific professors, we must give due praise to the toilers of pick and shovel.

The mineral resources of Australasia, though owing no little to definite exploration, have rather come to light by accident than design. To our surveyors, our mineralogists, our geologists, these treasure finds were seldom due.

In very early days, a special and urgent demand was made by our Governor for English lime, Port Jackson needing it for mortar. It was a number of years before vast deposits of excellent limestone were made known. A passing vessel on the road to India revealed our Port Hunter coal. In 1841, a careless driver had his dray wheel caught by the mountain road bank, when a vein of Adelaide lead was disclosed. A shepherd building a chimney to his hut was struck with the weight and colour of some lifted stones. The metallic discovery led to the working of the famous Burra-Burra. In the midst of Sturt's Desert are now both gold and silver mines. The gentle Mengé went dreaming among the South Australian hills, and told of jewels rich and rare.

In time we heard of silver-lead in Western Australia, the dry south-west of New South Wales, the dense thickets of North-Western Tasmania, as well as in South-Eastern Australia, the Alps and Cordillera on the Pacific side, and Western New Zealand. Copper came to the front in the southern and eastern ranges of Australia, and in the older rocks of New Zealand.

Coal came out first in New South Wales, which has still the most extensive deposits. The output there annually exceeds a million sterling. The last year's yield at sixty-nine collieries was 3,000,000 tons. New Zealand glories in good coal on its midland western side. Tasmania, though rich in seams, suffered much from the irruptions of destructive basalts. Queensland is wonderfully favoured with coal fields over a wide range. Victoria is developing carboniferous treasure.

Gold, meanwhile, was coy, and last in the field. A specimen here and there was picked up as a curiosity. The Rev. W. B. Clarke saw some in 1841. In that year, too, Count Strzlecki, in crossing the Australian Alps, came upon the precious metal so unmistakably, that he wrote of it to Governor Gipps. His Excellency, just then bothered enough with discontented squatters, had no fancy for a digging horde, and bade the Polish geologist hold his peace. In 1849, I visited the South Australian worked gold mine at Montacute, established by my Cornish mining friend, Mr. Phillips, in 1846.

One morning, about 1846 or 1847, when breakfasting with the late Hon. W. J. T. Clarke, at Hobart Town, he told me of gold having been found on his sheep station of Port Phillip, near the Pyrenees. At that time we were, not without cause, rather disloyal, and he jokingly spoke of fighting the expected English soldiery with plenty of good mutton, and leading them up country to dig for gold. Three or four years after, that neighbourhood was rushed by the miners of Buninyong and Ballarat.

When California displayed its golden gulches, Mr. Hargraves of New South Wales noticed how very like the Sacramento rocks were to those he had left near Bathurst. He returned to the colony, and at Ophir, in May, 1851, gathered the pretty nuggets, and raised the diggings' revolution.

It is needless to follow the tale of golden triumphs in the hills and vales of New South Wales, Victoria, Tasmania, Queensland, New Zealand, and now of Western Australia. To the advent of gold we, in Australia, have been greatly indebted for our increased progress in the arts, in science, in education, in political freedom, in press development, in commercial wealth, and in social civilisation.

In 1837 we had no gold mines. The last year's golden harvest of Australasia has been placed at over £9,000,000, If our colonies gained, the United Kingdom was greatly enriched by our auriferous success. When, in 1852, I heard the diggers sing the "Good Time Coming, Boys," I, too, dreamt of the age of gold in the worker's paradise. We did not then expect men labouring on wages, to pile up dividends for British capitalists. Well might the awakened digger exclaim "How has the gold become dim!"

The TRADE of Australasia before the Queen's Accession was quite inconsiderable. Payment for early importations was made in dollars, not gold, or by Treasury Bills the Commissariat supplied. The whale and seal fisheries furnished the primitive exports of oil, skins, and bone. There was some trade in New Zealand flax, colonial wool, and wattle bark. Apparel, hardware, and rum were leading imports. Rum served as currency in ancient times.

By 1837 New South Wales and Van Diemen's Land were the sole traders; South Australia being then in its first year's infancy. They had got emancipation from the thraldom of the East India Company, which had restricted colonial vessels in both navigation and cargo, and they had liberty to sell colonial products in London. Sydney and Hobart Town supplied the pioneers of Adelaide, Melbourne, Perth, Brisbane, and New Zealand with flour, building materials, sheep, cattle, and articles from Europe and America.

In 1837, the imports were valued at about £500,000; sixty years after, the Australasian ones rose to £50,000,000. You may have noticed in statistics that the direct importations from Great Britain seem at times less than those from neighbouring colonies; but we know that colonial vessels carry English manufactures to places according to the fluctuations of trade. Naturally enough, in early times, imports largely exceeded exports, as local manufactures were weak, and wants from Europe were many.

Changes in trade would be noted. Flax and oil gave place to agricultural supplies. South Australia now yields less copper, but more wool. Sydney and Melbourne have more general commerce. Queensland has added sugar to her cedar, wool, and minerals. Hobart, losing markets for timber, corn, and potatoes, looks more to metals and wool. Western Australia's activity is now great in imports. New Zealand relies on forests, minerals, and farm produce.

The total exports of Australasia may be reckoned at £66,000,000, and the annual return of shipping at near 20,000,000 tons.

Banking operation were feeble in 1837, though the banks now have deposits of £100,000,000 sterling. The depositors of Savings' banks in 1837 had not £40,000; they had in 1895 about £25,000,000. It was only in 1837 that Sydney and Hobart Town were declared free warehousing ports. The expansion of colonial shipping may be dated from the gold era. Increased population after 1851 augmented the tonnages of ships and the volume of trade. The variety of imported articles, not less than the quantity, formed a feature of more prosperous years. Railways eminently developed trade.

When quieter times came, town industries—previously neglected—occasioned a fresh direction of mercantile affairs. Machinery, little required before, became in large request, and as much in mines and farms as in the workshops. The stagnation following immense speculation is ever succeeded by fresh waves of commercial activity. The visitor to any colony has only to contrast the mercantile buildings and appliances of the past with the present palatial edifices and grand conveniences of trade, to realise the commercial progress of Australasia in this reign.

I decline to enter into the question of free trade and protection. The first has suited trade requirements in modern England. The other practice has been adopted by all Europe outside of us, by America, Canada, and Australasia generally. Either of the two may suit one condition of a country, to be succeeded by the other when local circumstances seemed to require it.

Explorations and discoveries during the Queen's reign have considerably contributed to our Australasian knowledge, and wonderfully promoted commercial relations. Excepting Captain Sturt's voyage down the Murray, and his glance over the glowing Adelaide plains, no one before 1837 knew the inland country of South Australia. Adelaide and King George's Sound were first connected by the terrible journeys of Eyre from 1839 to 1841. How little he thought that the golden rocks of Coolgardie lay beside his painful track.

In 1837, our G.O.M. of Australasia, Captain (now Sir) George Grey, saw the northern Glenelg, and traversed, hungry and faint, the thirsty plains of Western Australia. In that year H.M.S. *Beagle* explored our shore on the Indian Ocean side. In that year, too, the first stream of overlanders went with flocks and herds to Adelaide and Melbourne. Later on were the gallant efforts of Roe, Austin, the Forrests, and the Gregories.

Major Mitchell followed Captain Sturt over the Murray to the delightful Australia Felix. On Mount Macedon he looked eastward to Port Phillip Bay, and westward to Mount Alexander, in whose golden valleys the poor digger was to sing for joy. Then the Polish Strzlecki and Angus McMillan made known the Alpine passes and fertile plains of Gipps Land.

New South Wales interior had been opened before 1837 by Cunningham, Oxley, Sturt, Mitchell, and others. In 1844-5 Sturt entered the fiery stony desert, and was thrust back by the scorching sands. His more fortunate rival, Mitchell, went northward to his Plains of Paradise, his Mount Abundance, his Mantuan Downs, his gentle Claude, and his "beautiful recesses of an unpeopled earth." The German Dr. Leichhardt's career lay from 1842 to 1848. He brought to us the Mackenzie, Burdekin, and other streams on his way to Port Essington, and has been followed by shepherds, miners, and sugar planters. Surveyor Kennedy tried the thickets of Cape York Peninsula, but sank under savage spears. Burke and Wills, in 1860, made a wild rush to the northern sea, and died of exhaustion on the way home. Macdougall Stuart, after two vain attempts, reached Port Darwin in 1862.

New Zealand could speak of her Brunner on the west coast, and of Alpine clamberers and glacier crossers. Tasmania had her heroes of a jungle fastness. But the recital of explorations in this reign must end in the laudation of stockmen and diggers, unnamed, unsung, who have revealed for us the time-hidden charms of Australasia.

Political progress during this reign has been of marked significance. Originally brought up in the house of bondage, liberty sprang not forth, like Minerva, fully armed. When I landed at Hobart, in 1841, I found myself under a nominee council, having a few harmless free members constantly outvoted. But we had a very limited civil service, an expenditure below the income, and trifling taxes. So benighted were we then as to be ignorant of a public debt.

New South Wales—as the mother colony of Victoria, New Zealand, Tasmania, and Queensland—had to fight the battle of freedom for future millions. Let us do honour to her; admire her continued struggle, and reverence her faith in humanity. To those Sydney patriots of old we colonials owe our trial by jury, our right of representation as tax payers, our freedom of the press, our settlement on the lands, with our municipal government, and the equality of all religionists before the law.

You in London may criticise the exercise of our rights, and doubt the wisdom of our legislation. But, remember, our people were just what your schools, your churches, your laws had made us. We ran a bit wild in the freedom allowed us. Revelling in the boundless wealth of a patrimony bestowed upon us in land, without controlling conditions, the wonder is that we so mildly kicked over the traces, and that you here are so safe with your inscribed stock.

We have to meet a national debt of over £200,000,000. The 15,000 miles of Government railways, 120,000,000 sheep, an annual trade of £120,000,000 sterling, a revenue of £20,000,000, the vast area of unalienated lands, and the industry of the most energetic of peoples, are security for payment. If we leave our children something to pay, we leave them, also, a glorious heritage.

Religious freedom was first granted in Governor Bourke's Act, of July, 1836, which opened the treasury door alike to Protestant and Catholic, Presbyterian and Wesleyan. Later on, the State declined aid to contending sects, leaving theological teaching of both adults and children to voluntary effort and payment.

The *Educational* or *Intellectual progress* as exhibited in schools, the press, the institutions and societies for the promotion of knowledge, good morals, worthy citizenship and duty to

God, has been very satisfactory during this reign.

Until just before it commenced, the State only favoured schools belonging to the Anglican Church. The more liberal policy of Governor Bourke, afforded help to all schools established by the various denominations, Protestant or Catholic, according to the number of professing adherents.

The denomination system and the so-called Irish national system, gave place in the several colonies to public schools. After some evolution, all Australasia has adopted a non-sectarian mode, the aid being restricted to secular teaching. Some few voluntary schools exist, unsupported by the State, in which religious instruction, by catechism or otherwise, is given by the teacher; but, in the vast majority of schools, lessons in theology are left to parents and ministers.

Besides public schools, State help is given to evening schools, superior schools, grammar schools, technical schools, colleges and universities; while facilities are afforded for the youth of both sexes to advance from the lower to a higher order of instruction. Special attention is directed to female education, and the impartation of information to the working classes.

Not only are the schools made compulsory and undenominational, but, in New South Wales, Victoria, Queensland, South Australia, and New Zealand, they are open to all comers. The annual cost to the Australasian Governments is far over £2,000,000.

The Press progression is suitably placed among educational movements. In 1837, the few colonial papers had been but for half-a-dozen years freed from State censorship. A license was required, and could be arbitrarily withheld. Heavy personal securities were demanded in case of judgments for libel. Discretion was needed to escape fines and imprisonment. At this time, Australasian newspapers deserve meritorious notice, and they need take no back seat in the world's Press conclave.

The first *Sydney Gazette* appeared March 5, 1803; the first in Hobart Town in 1816. The *Port Philip Gazette* came out Oct. 27, 1838, though Mr. Fawkner's *MS.* paper came out previously with a few numbers. The *South Australian Gazette and Colonial Register* had its birth in London, June 18, 1836, and was published in Adelaide, June 3, 1837. The *Perth Gazette* dates from January 5, 1833, and the Moreton Bay *Courier* June 20, 1846. In New Zealand, the *Bay of Islands Gazette* preceded the *Auckland Herald*. Wellington had two newspapers in 1842, though the *Nelson Examiner* rose in 1841. The Maories had the New Zealand *Messenger* in 1844. The several colonies are patrons of both literary and scientific journals, and have furnished authors of some ability.

The Art world is well illustrated. Picture galleries of no mean pretention favour each capital. Music is particularly patronised, and extensively cultivated. The drama enjoys a great popularity.

Morals receive due regard from authorities and the Press, in spite of transmitted love of sport, and the national vice of intemperance. There is now to be found in those colonies a heartier support of all institutions for the benefit of humanity, a healthier denunciation of evil courses, a sincerer support of public worship, and a more enthusiastic devotion to the "good time coming," than was conspicuous among settlers sixty years ago.

We will now take a rapid glance at the progress of each colony during the Queen's reign.

NEW SOUTH WALES, the parent colony, was fifty years old when Victoria was crowned, and was then but in an infant state. The population was 77,000, Sydney containing 20,000 of it. The fixed or colonial revenue was but £217,869, and that from lands, &c., £128,500. The civil establishment cost £44,118; the judicial, £16,826; Church and schools, £14,500. Most of the expenditure, £305,000, was met by the British Treasury.

The imports were £1,182,222; the exports, £747,876. The fisheries, chiefly from New Zealand, brought £116,744. The wheat crop was 59,000 acres. The total cost of the colonial agent in England and the agent in New Zealand was then £950.

Sydney and Hobart Town were just declared free warehousing ports; the first bishopric of Australia had been just founded; the first land sale in Melbourne then took place, and bounties to emigrants closed in 1857; but South Wales was still the penal settlement of the United Kingdom.

At the end of sixty years the population was 1,277,870, besides 14,000 Chinese and 8,200 aborigines and half-castes. The revenue was £9,400,290. The inwards shipping was 5,860,000 tons. The imports were £15,972,415—two-thirds for home consumption. The duties were £1,974,827; the excise was £260,000. The exports came to £21,934,785.

Wool gave £8,958,600; silver and lead, £1,658,013; tallow, £738,316; meat, £695,137; coal, £772,954; tin, £138,623; copper, £131,866. The last noted gold produce was £1,315.922—a total to date of £46,000,000. The public debt was over £60,000,000.

Of the land, 45,000,000 acres had been alienated, and 125,000,000 leased. The savings' bank deposits were £3,951,875. The public library had 110,000 volumes. The State schools cost that year £768,807. The university had six affiliated colleges. The railways, 2,700 miles, cost £40,000,000. The stock had grown to 2,500,000 cattle, and 60,000,000 sheep. Manufactories had increased.

New South Wales had developed socially, intellectually, politically, and materially. The orchard, garden, vineyard, field, pasture, and rock had yielded everything that could add to the convenience, comfort, health, and wealth of the inhabitants.

VICTORIA, formerly the Port Phillip district of New South Wales, became independent in 1850. It was, in 1835-6, forcibly settled from Van Diemen's Land by squatting intruders. The rude port was named Melbourne by the Sydney Governor in 1837

The first census gave a population of 224, though springing to 500,000 a score of years after. Melbourne, in 1839, had but four tailors and three bakers; but traders came, for at the end of the first year, the exports were £12,176, though the imports were £115,379. Even in 1838 there were but 140 acres in crop, and the revenue was but £150.

A great change followed the gold discovery. The latest official record gave the population as 1,181,751; the revenue, £6,712,152; expenditure, £6,760,439; the people's savings deposits, £7,265,487; length of railways, 3,020 miles; and telegraph, 3,942. The rateable value of property in 58 of this colony's cities and boroughs was put at £65,000,000; not a bad set off to the public debt of £41,000,000, already well covered by the security of land, railways, and other national assets.

The trade imports were £12,472,344, of which £8,212,494 represented articles duty free in this reputed protection colony. The inwards shipping was 2,181,539 tons. Of the exports, England received £8,068,121. The wool realised £5,151,153; gold was £3,628,236; butter and cheese came to £1,009,602. A recent telegram stated last year's imports at £14,846,000; exports, £14,198,000; revenue, £6,579,969. The total yield of Victorian gold has been £245,000,000. An output of 280,000 tons of coal last year, and the produce of 12,000 town factories, further swell the volume of trade.

TASMANIA, as Van Diemen's Land, was a part of New South Wales till 1825. In 1837, the population was 42,000, two-thirds being males. The imports were then £563,640; the exports £540,200. The wool gave £171,000; the fisheries £127,077; the stock sold £105,000. The net revenue was £68,916. In 1837 nearly a hundred Tasmanian blacks were protected on Flinders Island; none of the race are now alive. Convicts continued to be sent to Hobart Town till the gold discovery arrested transportation thither.

A great change had come by 1895. The former colonial customers for timber, corn, and stock had become great producers, and the island colonists with no transports ceased to draw upon the British Treasury. But the population is now 160,000, with 1,500,000 sheep.

Imports by last returns were £1,094,457, one-third coming direct from Great Britain. The exports were £1,373,063, mostly going to neighbouring colonies. The wool produce, then £202,341, has been exceeded by gold at £212,530, and by silver-lead at £227,316. Tin fetehed £167,461; fresh fruits £130,313, and copper £96,617. The peoplc's savings were £650,000.

The area in cultivation was 236,345 acres. The debt was £8,180,925, of which the railings and telegraph lines cost one half. The revenue in 1896 was £807,696. Tasmania gained renown for having four successful school students sent free to a British University. The island is a summer holiday retreat of Australians.

QUEENSLAND was the Moreton Bay district of New South Wales till the end of 1859. It was a penal settlement in 1824, and not opened to settlers till 1842, when sheepmasters forced the cordon with their sheep to Darling Downs. Almost immediately arose the cry for "separation" from Sydney rule. In 1859 the revenue was but £6,475, with expenditure £8,689. An expansion began with 1860 under the first Governor, Sir George Bowen, and the enterprising Colonial Secretary (now Sir Robert Herbert). The imports rose to £742,023, the exports to £523,476; and the population to 28,000. The trade was then, however, in the hands of Sydney merchants. Queensland was essentially a pastoral colony, yielding an export of wool at £444,188, and £25,628 tallow.

Copper and gold had also made their appearance.

In 1895, the wealth in stock had advanced to 468,000 horses, 6,822,000 cattle, 19,857,000 sheep. The land in crop was 285,330 acres. The sugar industry had 80,000 acres of cane. The Government had 265,000,000 acres leased to stock-holders. Population had grown to 460,550, the revenue to £3,561,717, the expenditure to £3,374,761.

The imports had become £5,349,107, but the exports £8,982,600. The inwards shipping was 469,710 tons. The wool alone fetched £2,986,989; gold, £2,265,354; sugar, £796,117; tin, £74,187. The coal raised was valued £132,530; the silver, £30,142; copper, £13,094. The frozen meat sale promises better than ever. The produce of gold to date has been £45,000,000. The savings' bank deposits were £2,286,810.

The railways extend over 2,500 miles, and the telegraph lines to 10,000 miles. But the cost of construction over so vast an area has involved Queensland in a debt of £32,000,000. The schools, churches, libraries and other worthy institutions have kept pace with the material progress.

SOUTH AUSTRALIA had its first year's course at the Queen's accession. It began as a chartered company under the South Australian Commissioners. Population was drawn by the sale of land at a fixed rate per acre, so as to pay for free emigrants. After much blundering and extravagance the company failed. The British Government advanced £200,000, and declared the province a Crown colony in 1841.

In 1837, the population was 546, and the cultivation eight acres. The first land sale was in March, 1837. The revenue was but £1,448, but the expenditure £16,580. The exports were £6,442, and the imports £158,582. Debts accumulated, and the crash came. In 1840 the revenue was £176,000, but only £23,104 in 1842. Bad times mended when settlers worked their farms and developed their mines. The copper field of Burra Burra, 1846, turned the tide, paying for many years 800 per cent. dividends. Breadstuffs, especially at the gold rush of 1852 to 1856, brought good fortune to Adelaide.

The colony, in 1896, had a population of 350,000. The imports were £5,585,601, one-third from England, one-half from neighbours. The exports were £7,177,038, half of which were the produce of the colony. Nearly half the exports went to New South Wales and Western Australia. The wool brought £1,880,514; wheat and flour, £393,239; copper, £226,494. Adelaide has a large intercolonial trade.

There were 7,400,000 sheep, and a railroad length of 1,720 miles. But, as old purchasers of corn became producers, and competition increased, the want of productive gold fields was felt seriously. The public debt has mounted up to £22,000,000, and is a heavy burden. Internal progression in church, school, and savings' bank deposits tells us a good tale.

The courage and enterprise of Adelaide colonists entitle them to respect.

WESTERN AUSTRALIA, though established in 1829, had but 1,800 people in 1837, besides military. There were two small schools. There was a chaplain, but he had no glebe, no parsonage, no church—the court-house being used for service. There was a chapel for 100 at Perth. The bank-notes in circulation were worth £3,043, and the commissariat notes £400 extra. The circulating medium was chiefly Spanish dollars.

The exports for 1837 were £6,906, to which whaling brought £2,860, and the wool £1,680; but the imports were £34,200. In cultivation were 2,171 acres; the shipping was only 3013 tons; the stock consisted of 280 horses, 990 cattle, and 10,815 sheep. While the revenue was £3,888, the expenditure was £11,038, of which the British Ministry paid two-thirds. Four persons sat at both the executive and legislative councils; but there was no State debt.

The colonists, seeking home expenditure in their poverty, asked for convict importations, though transportation ceased there in 1868. A revival came. Silver-lead mines found an outlet, and the magnificent timber a purchaser. Gold began a humble course as early as 1885. No one can doubt the wonderful effect of Coolgardie upon the colony's social and commercial progress.

Two years ago the imports were £2,114,414; the exports, £1,251,406; the shipping, 675,775 tons; the railways 800 miles, and the population 100,000, now 150,000. The revenue for 1896 had mounted to £2,440,000. The sudden call for improvements has originated a debt already of over £4,000,000. The gold raised last year is valued £1,068,805. Civilization there, as elsewhere, follows in the wake of the gold miner.

NEW ZEALAND, in 1837, had a Consul to represent the mother colony of New South

Wales. Shortly after, the New Zealand Company was established, and failed. The islands were proclaimed a British colony in May, 1840. The Canterbury private settlement was founded in 1849, but collapsed in 1852. The Church of Scotland movement at Otago came to similar grief the same year. The British ministry had to make a grant of £43,347 in 1841, and £41,730 later, when £131,100 came from the commissariat.

Trade has increased with population. In 1895 there were 672,951 whites, and 42,000 Maori natives. The inward shipping rose to 640,129 tons. The imports were £6,400,129, of which Great Britain sent two-thirds. The whole stood at £9 4s. 10d. per head. The duties are regarded as very protective. The exports realised £8,550,224, or £12 7s. per head. Wool brought £3,666,231; gold, £1,162,180; frozen meat, £1,262,711; timber, £574,720; kauri gum, £418,766. The latest received figures are, £9,279,000 exports, to £7,034,000 imports, with a revenue of £4,662,100.

There were nearly 1,500,000 acres in crop. The savings' bank deposits were £609,490. The telegraph had 15,760 miles of wire, and the railways extended 2,014 miles. But the State debt was, in 1895, the sum of £42,271,868, in addition to £6,685,510 local borrowings.

The land laws are liberal. Over 20,000,000 acres had been alienated, and 10,650,000 were leased out. The live stock were 250,000 horses, 1,000,000 head of cattle, and 20,000,000 sheep. The school system is admirable, costing the State £500,000 a year. At the Government schools, 2,750 aboriginal youths were educated.

This rough statement of the past and present position of the seven Australasian colonies may serve to mark the forward leap, notwithstanding the recessions of prosperity-tides. Her Majesty has lived to see their populations rise to 4,500,000, and their trade expand from £500,000 to £120,000,000 sterling.

The pastoral wealth consists of 12,000,000 cattle, and 130,000,000 sheep. The annual returns from the gold alone is £10,000,000, and the silver £2,000,000. The export of wool has grown to 25,000,000. The bank deposits are £110,000,000, and the people's savings over £20,000,000. The shipping came to near 20,000,000 tons, the railways ran 15,000 miles, and the cultivation reached to 9,000,000 acres, embracing all that can be grown in both temperate and tropical climes.

The revenue, formerly dependent largely upon the British taxpayer, is now a free colonial one of £28,000,000. But the public debt has grown to nearly £200,000,000. Yet, of this, railways took £130,000,000, to say nothing of public works, as telegraphs and harbours, that are, or will be, highly remunerative. The federation of Australia may be shortly expected.

Better still, Her Majesty has lived to see the advance from penal dependencies to colonies enjoying the fullest extent of political and religious freedom; to hear of 800,000 children under State school instruction, and of churches and chapels spread abroad on the lines of perfect equality. There, too, as at home, may be recognised every variety of good work for the relief of the sick and poor, the higher education of workers, the support of literature and science, the repression of vice, and the culture of virtue.

Was ever monarch so honoured by such a survey of happiness and loyalty in a colonial empire!

DISCUSSION.

Mr. G. G. **MacWilliam** congratulated Mr. Bonwick on the admirable paper he had compiled, the facts collected being such as he thought would strike everyone with astonishment, although Englishmen in general were pretty well acquainted with the main features of the history of the Australasias. He was sorry, however, that he had not dealt more fully with West Australia, which was very lightly touched upon in comparison with some of the contiguous colonies, though he believed it would within no great period of time prove fully equal to others which for many years had enjoyed greater advantages, and that its population would increase by many thousands before another ten years had passed. He did not refer merely to the gold fields, whose prosperity might be evanescent, but to the whole of the south-west, from Perth down to Albany, and he regretted that Sir Malcolm Fraser had not done more to place before the British public the advantages they might derive from emigrating there. There was an idea still prevalent that the south-west was devoid of water, and subject to droughts and excessive heat, but this was an entire mistake. He only wished that the Government, in connection with recognised societies, would take measures for sending out some 5,000 or more carefully-selected emigrants yearly, advancing the money in the first instance, but taking a bond for its repayment, after a time, so that the movement would ultimately be self-supporting.

Mr. **Yardley** said there was really nothing to discuss in this paper in the way of criticism, Mr. Bonwick being *facile princeps* in dealing with facts and figures. It was exceedingly interesting to notice by his statements the wonderful progress of the Australian colonies during the 60 years of her Majesty's reign. He well remembered the first time he heard of Mr. Bonwick, which was in 1859, and how pleased he was to meet him soon afterwards, and hoped the friendship then formed might yet continue many years. He would remind the previous speaker, who seemed to complain that Sir Malcolm Fraser had not done as much as he might for West Australia, that the Agents-General of the Colonies in England were not altogether free agents, but acted under instructions. They were here to disseminate the most accurate information, by pamphlets, and by answering personal applications, which he could testify were very numerous, and he was quite sure they always did so to the best of their ability. *Apropos* of the gold rush of 1852 in South Australia, he might recall an interesting circumstance which was mentioned some years ago by the late Sir Arthur Blyth, Agent-General for South Australia. Sir Arthur read a paper at the Royal Colonial Institute, in which he stated that at that time the colony—especially the city of Adelaide—was practically devoid of coin; and so great was the commercial inconvenience that the Government passed an Act authorising the striking of tokens for circulation. In those days there were neither steamers nor telegraphs, therefore it took a long time before a local Colonial Act could arrive in England for the royal assent, and in the meantime the Act was put in operation. But inasmuch as the royal assent was not given, the Act became null and void, and the whole of the tokens which had been issued were recalled and melted up except 200; one of those which were saved happened to be in his possession. Mr. Yardley much regretted that the bad weather had kept away from the meeting Sir Saul Samuel, who had fully intended to be present.

The CHAIRMAN in proposing a hearty vote of thanks to Mr. Bonwick, said he had put before them in a wonderfully clear and lucid manner the marvellous progress which had been achieved in one important portion of Her Majesty's vast dominions during the last sixty years, marvellous progress in every possible direction, material and moral, throughout the British Empire. He did not like to criticise the paper in any way, but he must confess there was one point in connection with New Zealand in which he thought Mr. Bonwick had hardly done justice to some of those who were really the pioneers in founding that great colony. He spoke of the New Zealand Company, which was established in 1839, and shortly afterwards failed. Now he (the Chairman) was a shareholder in that company, and though he must admit that it did not succeed pecuniarily, he was proud to acknowledge his connection with it, for though in one sense it failed financially, he contended that it was, in reality, a marvellous success. It was that company, promoted by the genius of Edmund Gibbon Wakefield, which laid the foundation of New Zealand as a British colony, and had it not been for it, the French flag would now be floating over New Zealand. The same might be said of a subsequent company—an offshoot of the New Zealand Company—the Canterbury Association, which was founded in 1849, and collapsed in 1852, and with which he had a good deal to do also. Financially it was not a success, but it succeeded in establishing one of the most successful settlements of New Zealand, in the province of Canterbury. The Association used to meet near the Society of Arts, in Adelphi-terrace, and the settlement which had now become one of the most important and prosperous in New Zealand, was founded at that spot.

The vote of thanks having been carried unanimously,

Mr. BONWICK, in reply, said he was glad to hear Mr. MacWilliam call special attention to West Australia, which was really one of the most lovely portions of the continent, especially having regard to the floral beauties to be seen in the neighbourhood of St. George's Sound. He had been obliged to omit in reading some portion of what he had written respecting it. The stories which had been told in early days respecting it would prove as unfounded as those which were current at one time with regard to the western plains of Victoria. He quite agreed with what had been said by the Chairman about the companies which he had mentioned, which had left an imperishable glory behind them in Otago and New Canterbury.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 24, 1897; ALEXANDER SIEMENS, M.Inst.C.E., M.Inst.E.E., Member of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Hinds, Henry, 57, Queen-street, Ramsgate.
Scalé, James Bernard, 48, Bedford-gardens, Kensington, W.

The following candidates were balloted for and duly elected members of the Society:—

Harmer, Oscar, Hopedale, Spencer-park, Coventry.
Kirk, Percy, M.A., Seafield Technical College, Fareham, Hants.
Pither, Ernest Eugène, 36, Mortimer-street, W.
Scriven, Charles Herbert, Thong-house, near Gravesend.
Smail, John Isdale, Black Mount, Chislehurst.

The paper read was—

THE TRANSMISSION OF POWER TO LONG DISTANCES BY ALTERNATING CURRENTS OF ELECTRICTY.

By W. B. Esson, M.Inst.C.E., M.I.E.E., &c.

This is not the first occasion on which your attention has been directed to the subject of the transmission of power by electricity. Mr. Gisbert Kapp in 1891 delivered an excellent course of Cantor lectures, which dealt very fully with what had been done up till that date, but from then till now the progress in this particular department of applied electricity has been so great, that the value of the 1891 lectures has becomes chiefly historical. It would be quite impossible for me, in view of the enormous strides made in recent times, to deal adequately in a single paper with electric transmission of power generally, so as implied by the title I propose to limit my remarks at present to transmission by alternating currents and to long distances. In so doing I cut out a vast field of application, but I can in consequence deal more fully with the branch I have chosen, and it will be remembered that transmission by direct currents in its most important application, viz., to street railways, was dealt with here by Mr. Parshall only a year ago.

Starting then where Mr. Kapp left off in 1891, you will perhaps remember that in the last of his Cantor lectures he apologised for taking up the time of the audience with the very interesting exposition he gave of the theory of polyphase motors. He described his observations as leaving "the safe ground of solid facts and engineering practice to enter into the domain of speculation," declaring, however, his conviction that some form of alternate current working would cause the ultimate solution of the problem how to transmit power—possibly over all distances—but certainly over very long distances. Well, that prediction has been marvellously fulfilled, for all long distance transmission work is done by alternating currents and nearly all by polyphase motors.

The alternating current systems at present employed for transmission work are enumerated in the following classification of generators, conductors, and motors.

It is impossible to discuss either of these three principal factors in power transmission without some reference to the others, but it will be nevertheless convenient to divide my remarks into the headings given, and to keep to the order indicated.

	Generators.	Line.	Motors.
1.	Single Phase	Two wires	Synchronous or Non-Synchronous.
2.	Two Phase	Four wires or Three wires	Synchronous or Non-Synchronous
3.	Three Phase	Three wires or Four wires	Synchronous or Non-Synchronous
4.	Mono-cyclic	Three wires	Non-Synchronous

I.—Generators.

It will be seen that the generators are single-phase, two-phase, and three-phase, corresponding to the three well-known systems of power transmission. As we shall see later, the mono-cyclic system, for which the fourth generator on the list is required, is an ingenious combination of single-phase and three-phase systems. The single-phase machine, as its name implies, generates one alternating current only, which may be represented by the wavy line on this diagram on the wall. The two-phase machine generates two distinct alternating currents displaced relatively to each other by a quarter of a cycle as represented by the two lines, one full and one dotted in the second diagram. It will be seen that when one of the currents has its maximum value, the other has always a zero value. The three-phase machine produces three distinct alternating currents displaced relatively to each other by one-third of a cycle, which may therefore be represented by the three lines, one full, one dashed, and one dotted in the third diagram. In these diagrams the horizontal distance represents time, and vertical distances the magnitude of the currents, the part of the curve above the line representing the current in one direction, and below the line the current in the other.

Every alternating current lighting station in the kingdom is equipped with single-phase generators—you are doubtless familiar with several types—and the high pressure distribution is effected of course on a two-wire system. In two-phase working the respective circuits may be kept quite distinct throughout, or one termination of both circuits may have a common junction, there being then three terminals for the line. If the circuits are independent, four line wires are employed; if joined to three terminals only three wires are used, one rather larger than the other two, being common to both circuits.

In three-phase working, the algebraical sum of the currents in the three circuits, provided perfect balance is maintained throughout, is *nought*, accordingly in a return wire, common to the three circuits, no current would flow. On this account it is usual to dispense with a return conductor for the transmission, all three circuits having a common junction at each end of the line, and three wires only being used. As we shall see later, a fourth wire for the distributive part gives advantages which are well worth consideration.

In selecting generators for power work, several very important considerations have to be kept in mind. In the first place, it is essential that the machines be of first-class construction, from a mechanical point of view, as alternators employed for power transmission have, so far as my experience goes, to work under conditions much more trying, than have machines for lighting. From advices to hand while I write,* for example, I learn that the two-phase generators at the Sheba mines ran all through September, night and day, from the first to the thirtieth, without once stopping. Such runs try machines severely, but not only may transmission alternators have to work continuously, but they are generally fully loaded. This further tests their staying qualities, making it imperative that nothing but designs of the soundest engineering character should, for this kind of work, be thought of.

It is essential that the armature coils be not subjected to stresses which tend to alter their shape, or to destroy, in time, the insulating materials. Such substance as mica, micanite, stabilit, presspahn, &c., are quite unfitted to transmit force, accordingly all alternators for power work have their armature coils embedded in a laminated iron core. In some cases, the wire forming the coils is wound through holes in the core plates, while in others the coils, independently formed, are placed in slots punched perpendicularly to the surface of the core; but there are no conductors in the gap between the field magnet and armature core. In the case of the coils in slots, these are machine wound on a former or mandril, and thoroughly bound together with several wrappings of rubber-impregnated tape or other suitable insulating material before being put in place. Generally, in American machines, the armature is the rotating part, while in European machines it is the fixed part. In the rotating armatures, the machine-wound coils are firmly wedged into radial slots on the surface of the core. Other things being equal, a stationary armature is to be preferred, because the armature is the high pressure part of the generator, and when stationary it can easily be protected, so that accidental contact with the circuit is absolutely impossible.

That the efficiency of the generator or ratio of electrical output to mechanical input of power should be as high as possible goes without saying, but it is, perhaps, of still more importance that the armature re-action should be very small. Armature re-action is manifested by the drop of pressure from no load to full load, and in large alternators for lighting work a drop of from 10 to 15 per cent. is not unusual under conditions of constant excitation and speed, nor does this cause any inconvenience. But for running non-synchronous motor circuits, such a generator would be quite unsuitable. The motors act like so many choking coils, the result being that the same generator, which has on an inductionless lamp load a drop of no more than from 4 to 5 per cent., will have, when working on a motor load, a drop from four to five times as great. It is very important, therefore, that any alternator intended to be used for power transmission shall have a small drop tested on an inductionless load, seeing that on the power circuits this drop is greatly magnified. High efficiency does not necessarily mean small armature reaction, but since the satisfactory working of the plant greatly depends on securing the latter and avoiding difficulties of regulation which would otherwise occur, it will be obvious that a certain amount of power may be sometimes wisely sacrificed to attain this desirable end.

Another important point, of course, is the size of the generator. In the preceding paragraph I have spoken of polyphase motors acting as choking coils, and an inductive load, as you are no doubt aware, not only causes a large drop of pressure at the generators, but also makes the current lag behind the impressed E.M.F. As their phases are not coincident, the product of virtual amperes and virtual volts does not give the power in watts going into the circuit; to get this latter the product has to be multiplied by a co-efficient depending on the difference of phase. This co-efficient is called the power-factor, and is the fraction which expresses the cosine of the angle of lag; it is the ratio of the *real* to the *apparent* watts given to the circuit. As we shall presently see, the power-factor has a different value for different sized motors, and lies somewhere between ·65 and ·85. If two-thirds of the power given by the generator were taken up by non-synchronous motors, the power-factor would probably be about ·8 for the whole circuit; but if the power were nearly all taken up by motors large and small mixed, it would be less than this; certainly it would not be safe to take it as exceeding ·75 at the outside. Now what does this signify? It means that the generator must be at least one-third larger than it would require to be if the phases of current and E.M.F. were coincident. Because the power factor is ·75, the machine has to supply one-third more currrent to the circuit, in other words if we wish to give 100 electrical h.-p. to the line we must provide a generator capable of giving 100 kilowatts on an induction load. It also means that our lines must be one-third heavier because of the extra current to be transmitted, and our transformers, if we have any, must follow suit and be installed of a capacity equal to one kilowatt for every horse-power. It will be seen that an increased power factor would result in a reduced outlay for the plant all round, but of this more anon. At present I need only say that it is most desirable to provide everywhere ample margin, and plant should be provided at the rate of not less than a kilowatt per horse-power transmitted as stated above. Though some motors may have a higher power factor than ·75, many have less, and it is well always to be on the safe side.

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* November 9th.

Now comes the question of the number of reversals of the current per second, regarding which there has been a good deal of discussion. British engineers are accustomed to talk of the number of complete cycles per second, meaning by *cycle* a current first in one direction and then in the other, as indicated by the complete wave *a* to *b* in this diagram. Instead of repeating "complete cycles per second" every time however they use the word *frequency*, so that a "frequency of 50" means that the current is reversed 100 times per second, or that there are 50 complete cycles per second. In the working of synchronous motors the frequency question is of comparatively minor importance, but with regard to non-synchronous motors which are now almost universally employed for power work, it is of the greatest importance. There is no particular frequency, the best under all circumstances, but it must be remarked at the outset that whatever the views held by lighting engineers, all who have had experience of power transmission agree as to the desirability of a low frequency; so far as power *per se* is concerned the lower the better. You are doubtless aware that in the States the first alternating current plants were run at a very high frequency. The ordinary thing was from 125 to 132, a figure which was very suitable for scattered distribution and small transformers. With the development of alternating current motors however the frequency for the standard designs of alternators has gone down to 60, while for machines which have to supply currents for power only, the figure has been reduced to about 30. In the case of Niagara and some other large plants it is 25. In Europe the frequency for power transmission work ranges from 40 to 60, and the mean of these figures, 50, is about the lowest that can be adopted consistent with obtaining satisfactory results on the lighting circuits, which are in a greater or less degree generally combined with power transmission. At 50 the fluttering of arc lamps, when they are enclosed in opalescent globes, is inappreciable at a distance of a few yards.

It will be seen then that engineers have had to remodel all their designs for the purpose of power transmission, consequent on the high frequency permissible, nay advantageous, for lighting, being altogether unsuitable for circuits running non-synchronous motors. Anything above 60 is to be viewed with distrust, and we would go down to half this, or even below, if we could then, in a satisfactory manner, operate lighting circuits without introducing complications too costly to be justifiable. When we go above 60 we begin to get into trouble with generators, line, and motors all round. This is not the place to go into the many practical and theoretical considerations which have led to the universal adoption of the low frequency; suffice it to say that only the strongest reasons induced one engineer after another to alter his designs to suit power transmission work. Experienced men are all agreed as to advantages of low frequency, and it is a matter for congratulation that there is specified for the electric lighting works now in progress a frequency only about half of what was usual some time ago. As a consequence, the circuits are rendered much more suitable for the working of motors.

Another thing of some importance is the form of the E.M.F. curve of the generator. Shall it be flat-topped, or resemble the teeth of a saw, or be like any of the irregular figures shown by Dr. Fleming in his recent lectures on transformers, or shall it be a sine curve pure and simple. Well, the opinion universal amongst engineers having to do with power transmission, is that alternators giving a sine curve for the E.M.F.'s are in all respects the most suitable. It has been shown, as you probably know, that so far as hysteresis loss in transformers is concerned, the saw tooth curve is best, but in transmission work there are many other things to be considered, and experience has shown what one might almost have arrived at by intuition, namely, that for smooth running a simple harmonic curve is best of all.

But to return to construction. The first polyphase generators consisted of a couple of ordinary alternators having their shafts rigidly coupled together so that the two currents produced by them were displaced by a quarter period. This was costly, inasmuch as two small machines are more expensive than one large one, and the next step was to combine the two machines in one, thus producing a two-phase generator proper. The most obvious way of doing this, so far as machines with rotating magnets were concerned, was to displace one half of the fixed armature coils relatively to the other half, so that the currents of different phases were generated each by a separate half of the fixed portion of the machine, the magnets being common to both. The generators constructed by Messrs. Johnson and Phillips for the Sheba Mine plant, one of which is shown by the lantern, were of this type. The armature consisted of a number of iron sectors, which as will be seen from the photograph were mounted in a cast-iron shell made in two halves. A machine wound coil was fixed on each sector, the shape of the sector with its coil complete being apparent from the two spare ones to be seen lying beside the machine. The seven coils in the top half generates one current, the seven in the bottom half the other, with a phase difference between them of 90°. Each current has a virtual difference of potentials of 3,300 volts, so that every coil is responsible for about 470 volts.

Generators of the above type, though capable of doing excellent work, are no better as regards armature reaction than are single-phase machines. Each semicircle of coils reacts separately on the magnet to weaken the field, and produce other effects which can well be dispensed with, while obviously it would be of advantage to usefully employ some of the space on the armature presently unoccupied by windings. As I have already said, the drop in pressure between no load and full load depends primarily on armature reaction, it is desirable therefore that any way of arranging the coils be adopted by which the reaction can be reduced. When we want to keep the reaction low in single phase generators, we make the number of convolutions on the armature coils as few as possible, the field as strong as possible, and the air space between the armature core and magnet tips fairly large. In polyphase generators we can do all these things, and one thing more which greatly helps us, that is, mix the coils of the several phases. This latter constitutes an important point of difference between the machines just described and those now constructed by the same firm. One form of armature with mixed coils is shown on this photograph, and consists of a number of laminated iron sectors mounted in a cast iron shell as before, but in each sector are embedded two machine-wound coils displaced relatively to each other by a quarter phase. The sectors are built up independently by laying charcoal iron plates one on the top of the other until the necessary depth is obtained, the corners of each plate being bent out of the way to get it over the coils, and straightened back again when in position, and before the next plate is put on. It will be seen that instead of there being semicircles of coils all of one phase reacting upon the magnets, what effect there may be now, is due to the resultant of the two currents of different phases flowing in the intermixed coils. The result is that the reaction is greatly diminished, also that whereas the machine first described could only give for similar carcase dimensions, as a two-phaser, the same output it gave as a single phaser, from the new machine with the intermixed coils there can be obtained, the carcase remaining the same 25 per cent. more output.

Armatures with their coils wound through holes in the core plates have also the windings of the different phases intermixed. In such cases a micanite tube is first inserted into the hole and the wire is wound through it. This figure shows part of an armature having a hole winding for two phases, while this other figure shows part of an armature in which machine-wound coils are laid into slots punched on the interior surface of the core. It is to be observed that both in the case of the armature formed of sectors and the hole-wound armature the core surface presented to the field magnets is smooth; in the case of the armature with the coils laid in slots however, the core surface is to some extent discontinuous.

Other things being equal it is of advantage to have a construction such that the armature coils can be readily replaced by spares in case of an accident. In Johnson and Phillips's two-phase generators just described, each sector being independent, it can be replaced in a few minutes, and that without disturbing any of the adjacent sectors or making any other preliminary preparations, such as lifting the top half of the armature, racking the halves of the armature apart, or lifting the field magnet. In the machine with the armature coils wedged into slots the coils can be removed, but not without some trouble, and then either the halves of the armature must be racked open, or the field magnet lifted. With the hole winding, independence of the coils cannot be readily secured, and in the case of a burn-out, the machine has to be shut down while the repairs are effected.

Three-phase generators, in which the coils belonging to the different phases are intermixed, may have hole windings, but armatures for three phases can also be built up of movable sectors, each having one coil. When so constructed, each third coil counted round the armature belongs to the same phase, and the coils are therefore coupled in three sets, so that if they are numbered 1, 2, 3; 1, 2, 3; 1, 2, 3; all round, all the 1's will be in one set, all the 2's in the other, and the 3's in the third. The armature reaction, in a machine of this kind, is greater than with intermixed coils, but it is certainly not so great as in the case of a single phase, or of the two-phase machine, with the sectors in separate semicircles.

Having said so much regarding the armature, we may shortly consider the field. The magnet of the Sheba generators consists of a star-shaped steel casting in two halves, excited by a single coil wound on a central boss, from which project **N** poles on one side, and **S** poles on the other. These polar projections are bent round and interlaced so as to form a circle of **N** and **S** poles, alternately running with a clearance of one-third of an inch or so between the tips and the armature core. This form of field magnet was employed originally by Mr. Brown for the well-known Frankfort-Lauffen transmission, and has the advantage of requiring a very small amount of copper for excitement, as compared with other forms. It has, however, the disadvantage of a comparatively large stray field, with the exciting coil at some distance from its work, and the consequence is that when loaded on motors a large proportion of the induced field never enters the armature, a considerable drop of pressure with the load resulting. I have just said that to keep the armature reaction small the field must be strong, and as this strength is wanted between the field poles and the armature, the importance of getting the magnetising force as close as possible to the magnet tips will be obvious. On this account the multiple coil magnet has been more largely used for power work than the single coil magnet, as the coils of the former can be brought close up to their work. If the single coil magnet is employed, the designer must bear these points in mind, also he must keep the masses of iron in the poles as small as possible. The single coil has not yet been used for generators with rotating armatures.

Whether the magnets require to be laminated depends upon the construction of the armature. With an armature core presenting a smooth surface to the magnet, the air gap being uniform and things arranged so that the magnetic reluctance is for all positions of the magnet the same, lamination of the field is not very necessary. The armature built up of sectors as already described, complies with these conditions as well as armatures having hole winding. But for armatures having open slots to receive the coils, lamination of the magnet is necessary, if not throughout at least the tips must be laminated. In the best known American machines the magnets are laminated throughout; they consist of sheet iron stampings bolted together.

Generators are designed to give from 2,000 to 3,000 volts for small outputs, and from 3,000 to 5,000 volts for large sizes. In very large machines a pressure of 10,000 volts could no doubt be managed, but then it would be just a question as to whether it would not pay better to generate at low pressure and raise the voltage for the line by means of step-up transformers. At present the practice is not to exceed in the generators 5,000 to 6,000 volts, and the experiment of running at higher pressure for power work has yet to be made.

The mono-cyclic generator is peculiar to the "monocyclic" system, which deserves remark as constituting a means of preserving the simplicity of single-phase distribution for lighting while securing the advantages of a three-phase system as regards the starting of motors and to some extent their running. I regret that the time at my disposal does not permit me to describe this very interesting system. It has made I understand some headway in the States, though I do not know that there is much scope for it in this country, or that it will be employed for general transmission work to any great extent.

II.—THE LINE.

The line conductors may be laid under ground or carried overhead, but the latter plan is almost universally adopted. In the case of underground, the best practice is to use cables insulated with some fibrous material impregnated with a resinous or bitumenous compound and lead sheathed. Over the sheathing it is yarned, then armoured by steel tapes, again yarned, and well compounded on the exterior. Needless to say whether for the main transmission or for use only where overhead wires are undesirable the conductors must be concentric or twisted together. Such a cable can be easily laid, and no skilled labour is required save in making the joints. It is simply put in a trench which is filled in again when the laying is completed. The question of its being in the wet or dry enters very little into account provided it is not laid in a clay soil which in time would prove detrimental to the lead covering. Before you on the table is a sample of concentric cable such as I describe, 20 miles of which were made for Messrs. Johnson and Phillips by Callender's Company. It has been laid down for the power plant at the Sheba Mine, and before shipment from London every length was tested after 24 hours immersion in water, with an alternating pressure of 10,000 volts between the conductors, and 5,000 volts between the outer conductor and the lead covering. The inner strand consists of 19 wires ·057 ins. diameter, and has a cross section of a twentieth of a square inch when stranded. The outer conductor has also 19 wires of ·057 ins. diameter, stranded on in two segments. The insulation between the inner and outer conductor is ·35 ins. thick, and between the outer and the lead ·23 ins. thick. The lead sheath is $\frac{1}{10}$ in. thick. On a bedding of jute above the lead are laid two steel tapes, and outside these is a finishing layer of jute yarn stranded on and dressed with hard compound. The outside diameter of the complete cable is 2·3 ins.; its conductivity resistance is ·88 ohm per mile for each conductor; its insulation resistance above 1,500 megs. per mile between inner and outer conductors, and 800 megs. between outer and lead; its capacity is under one-half microfarad per mile.

But as I have said, overhead conductors are in almost universal use. They are in any case much less costly than underground cables they are more easily repaired in case of a breakdown, and are much better adapted for very high pressures. In putting them up the best telegraph practice is followed, though of necessity the scantlings are everywhere more substantial. The poles are spaced from 30 to 50 to the mile, and from 25 to 50 feet high as circumstances demand. They are generally of timber procurable in the district, for the Niagara to Buffalo transmission, for example, they are of white cedar, while for transmission lines in California they are of cedar or tamarack. But sometimes they are of the stronger and more durable material, iron, as, for instance in the line now being erected by the Central Electric Works Company on the Rand.

The insulators are fixed on cross arms of wood or iron in the usual way, but they must be of special form to secure the high insulation necessary. Oil insulators of the pattern originally introduced by Messrs. Johnson and Phillips have been largely used, and the lines of the historical Lauffen and Frankfort transmission were carried on these. One well-known form is on the table. The insulator has an internal and external bell projection, and the former dips into an annular trough of oil, the trough being movable on the bolt so that it can be readily lowered for the purpose of cleaning by merely taking out a pin. The insulation is practically perfect in this form of insulator, even where moisture abounds, as before the current could go to ground it would have to cross a surface of oil. It will be seen that the oil trough is thoroughly protected from wet, and the insulator is particularly suited to climates where excess of moisture is present, and where, therefore, the additional care of the oil is well repaid by the extremely high insulation obtained. But for ordinary climates oil has been given up, and we rely upon insulators so designed that the current would have to leak over a long path before getting to ground. On the table is one of Johnson and Phillip's insulators for high voltage transmission work. It will be seen that it is made very deep, and that the sides of the grooves are perpendicular, so that there can be no lodgment of dirt or dust. An insulator of this form is quite suitable for a working pressure of 3,000 to 5,000 volts. An insulator supplied by the same firm for still higher pressures is here. Here it will be seen that the surface over which the current would have to pass to get to ground is very considerable, in the actual insulator it is 12 inches from the binding wire to the bolt, of which over 9 inches is on the underneath side. This insulator is made of the finest porcelain fired at a very high temperature, it will stand a pressure of 100,000 volts, before puncture, and is perfectly suitable for a working pressure of 10,000 volts. The insulators used for the Niagara-Buffalo transmission are of somewhat similar shape, but in the latter there is a gutter round the bottom of the outside bell designed so as to drain away the water on each side clear of the cross arm. The construction of the gutter is such that only at two points, both clear of the arm, can icicles form. For the Montmorency-Quebec transmission, a somewhat similar insulator is used. It will be understood that on occasion special insulators have to be used as when the line goes up steep inclines, thus bringing considerable strain on the supports. At times also, it has been found advisable to insulate the line wires for a few feet, where bound to the insulators, by means of wrapping them with sheet rubber and compounded tape.

As regards the conductors we shall see later how their size is to be determined, but whether they are laid underground or fixed overhead it is of the utmost importance that the generators, transformers, motors, &c., to which they are connected be efficiently guarded from lightning. It might, at first sight, be thought that there is no need to fix lightning guards to underground conductors, but the effects of induced discharges have to be guarded against just as carefully as have the effects of direct discharges. The kind of lightning guard in use for telegraph and telephone work is not adapted for power transmission. Generally the apparatus for the former consists of a simple spark gap, and as the electromotive force at which the circuits are worked is comparatively low, such a device serves the purpose for which it is intended most satisfactorily. But when there is a pressure of over 2,000 volts and a reserve it may be of hundreds of horse-power available for maintaining across the gap an arc started by the lightning, it will be seen that in transmission work a somewhat different set of conditions comes into play. By the use of lightning guards, we endeavour to do two things, first to conduct the direct or induced lightning charge as quickly as possible to ground, and thereby prevent damage to the apparatus and machinery; secondly, in the case of overhead lines to prevent the lightning from striking the conductors at all. In designing efficient guards to effect the first object the difficulties encountered were solely due to the fact that to maintain an arc across a gap requires much less pressure than is required to start it; in other words, the pressure required to make a spark pass between two points in a normal atmosphere is enormously greater than the pressure which will maintain a large current between the same points when the space is filled with carbon particles or metallic vapours. If across an ordinary spark gap between a high pressure line and ground an arc were started by a lightning discharge, there would be nothing to prevent the generators from maintaining after the discharge had passed a large current across the gap, practically short-circuiting, and in all probability damaging themselves permanently before the fuses blow. Obviously then one of two courses has to be adopted. The first course is to provide a gap, which though normally set to the amount which the lightning can jump, is automatically lengthened immediately the discharge has taken place to such dimensions that the generators are unable to maintain an arc across it. Guards of this type have been devised by a great many inventors, the best known probably being the Thomson-Houston. In this the discharge takes place between two curved horns pointing upwards, and the arc when formed is repelled by an electro-magnet until it goes out, the distance between the curved horns gradually becoming too great for the machine pressure to keep it going. Though this guard acts very well and generally breaks the arc promptly when formed, manifestly it would be much better to prevent an arc forming, and the second course open to us is to use a metal alloy, such that the starting of an arc in the gap becomes an impossibility. This is achieved in the Wurtz guard lying before you, an apparatus which recommends itself on the principle that "Prevention is better than cure." It consists of a row of metal cylinders 1 in. diam. by 3 in. long, placed side by side parallel to each other, and each separated from its neighbour by a gap of $\frac{1}{32}$ inch. The metal is an alloy of zinc and antimony, and when a discharge has passed there is nothing to mark the path it had taken save a small pit or burn. With the cylinders spaced as above, an arc cannot be maintained between them, the dense oxide vapour produced being non-conducting and unable to carry the current. This guard is always in a condition to protect the line, as the dimensions of the gaps are never altered, and so far as my experience goes its action appears to be all that can be desired.

All lightning guards depend as regards their action on the fact that a lightning discharge prefers to make its way to ground across a small air gap rather than through the coils of the apparatus, which are in parallel with the path to ground. It will be apparent that coils possessed of self-induction, having an influence quite negligible when considered with reference to the working frequency, may offer enormous opposition to the course of the highly oscillatory discharge of lightning. Seldom therefore does lightning damage the machinery when a proper guard is used, but it is nevertheless often advisable to introduce chokers for the purpose of supplementing the opposition which the coils of the generators would offer alone to the discharge. These chokers consist of coils offering practically no opposition to the normal current, but choking effectually any attempt to go through them on the part of the lightning. The combination of Wurtz gap guards and chokers has been adopted with success for several transmission plants. Whether the conductors be underground or overhead, efficient guards such as I have described must be employed to protect the apparatus at both the generator and motor ends of the line; at intermediate points they are not required.

The guards described provide a path to ground for direct or induced charges, but as already stated, for overhead lines another kind of guard is employed by which we endeavour to prevent the lightning from striking the line at all. If once the lines are struck the guards already described will doubtless protect the apparatus; at the same time the precautionary measure of keeping, if possible, the lightning off the line is well worth taking. The well-known lightning spike used in telegraphy is the simplest of these guards. It consists of a pointed rod of wrought iron secured to the cross arm by the insulator bolt and having its point projecting some inches above the line. One of these spikes is fixed at each insulator, care being taken to make a thorough good connection from them to ground. A better guard is a bare iron wire running the whole length of the line fastened on the top of the poles. This may be barbed fence wire, and it should be grounded every third or fourth pole. For the protection of the Niagara-Buffalo lines barbed wires are employed, grounded every 500 feet or so, for the Montmorency-Quebec lines strong galvanised iron wires are used run on the extreme ends of the top cross arms, while the Tivoli-Rome lines have a single wire run on the top of the posts. These methods of guarding have proved very efficient, but needless to say the greatest care must be taken to ensure a good ground connection; failure in this respect may render the guards not only useless, but worse—an actual source of danger.

I now come to the size of conductor to be used, which depends on—

(*a*). The system to be used.
(*b*). The working pressure.
(*c*). The power to be transmitted.
(*d*). The loss permissible in the line.

The total weight of copper required for transmission by two-phase currents employing four wires is, with the same loss in the line and same working pressure, exactly the same as required for single-phase transmission, though, in the former case, each wire has, of course, half the sectional area. This is on the supposition that the same type of motor is used, as it would not do, for comparison, to assume non-synchronous motors in one case, and synchronous motors in the other. Call this weight 1. If, for the two-phase transmission, we use three wires instead of four, making the third which replaces two, common to both circuits, this third wire need not be double the area of each of the other two, but only 1·4 times, and under these circumstances the weight of copper will be ·85 against the former 1. If three-phase transmission, with three wires, is used, the figure for the relative weight of copper depends entirely upon what is assumed as the standard of comparison with reference to the strain upon the insulation of the line and the apparatus connected to it. If we assume that there is, between any two of the three wires, the same difference of potentials that there is between each pair of wires comprising a circuit of the two-phase system, the weight of copper is represented by the figure ·75. So far the weights are:—

1.	Single-phase system, two wires....	1·0
2.	Two-phase system, four wires	1·0
3.	Two-phase system, three wires	·85
4.	Three-phase system, three wires ..	·75

It will be seen that, on the three-phase system, the same power can be transmitted by three wires, as can be transmitted by four wires of the same size, working on two phases, it being assumed that the loss in the line is the same in both cases.

The second factor determining the size of conductors is the pressure to be adopted, this being one of the first things which has to be decided when a transmission scheme is being worked out. The pressure influences very materially the cost of line construction, as the weight of copper in the conductors is, for transmission, of the same power with the same loss in the line inversely as the square of the pressure. For economical reasons, therefore, it is desirable that a pressure be decided upon as high as the conditions render practicable, while for long lines high voltage is imperative.

We have seen that generators can be readily wound for pressures of from 2,000 to 5,000 volts; 25 horse-power motors can be wound for 1,000 volts, 50 horse-power for 2,000, and 75 to 100 horse-power for 3,000 volts. Still larger motors may be wound for 5,000 volts, and it should be remembered that with the high pressure part at rest, the exposed rotating part is subjected to no higher pressure than if the current entered the machine at only 100 volts. The high pressure part can be completely protected, so that it is impossible to touch it, consequently, high pressure is attended with no extra danger to the man in charge of the motors. It will be seen then that in the case of transmitting power to a group of large motors, there is no need to use step-up and step-down transformers as an essential part of the scheme until the distance exceeds that at which a pressure of from 3,000 to 5,000 volts is economial. Transformers need only be used to step-down the lighting circuits and for such motors as may be too small for winding for the line pressure.

In deciding upon the pressure, we have to consider the sizes of the motors we are going to use. Large motors may be worked at the line pressure just mentioned, but if the bulk of the energy is to be employed for motors of medium power it might pay to reduce the line pressure to a suitable figure for the bulk, putting more copper into the conductors, but saving the cost of transformers. If the motors rule so small, however, that the whole of the current has to be transformed, there is no use in working the line at less than 3,000 volts. It is desirable to illustrate these points by an example:—Suppose we have to deliver 300 h.-p. at some distant point made up:—

Ten motors of 10 h.-p....... = 100 h.-p
Four ,, 25 ,, ... = 100 ,,
Two ,, 50 ,, ... = 100 ,,
Total .... 300 ,,

Let us say that the limiting voltage for the winding of the motors is:—

For the 10 h.-p. motors = 300 volts.
,, 25 h.-p. motors = 1,000 ,,
,, 50 h.-p. motors = 2,000 ,,

We will leave 300 volts out of consideration as a pressure suitable for the lines. Taking transformers at 50s. per horse-power[*] all round we have as the expenditure on transformers for different line pressures—

Working at	For the 10 H.P. Motors.	For the 25 H.P. Motors.	For the 50 H.P. Motors.	Total Transformers.
1,000 volts	£250	..	..	£250
2,000 ,,	£250	£250	..	£500
5,000 ,,	£250	£250	£250	£750

This means that if we work at 5,000 volts, we require transformers for all the motors; if we work at 2,000 volts, we require them for the 25's and 10's, while if we work at 1,000, they are required for the 10's only. It thus appears that working at 1,000 volts, we could expend on the line about £500 more, and working at 2,000 volts, about £250 more than we could working at 5,000 volts., the total cost of the scheme coming out no higher. Taking copper at £65 per ton, and assuming for the time being that the other items making up the cost of the line are constant and independent of the size of the conductors, we can increase the weight of copper for 1,000 and 2,000 volts by about 7·7 tons and 3·85 tons respectively, over that required for 5,000 volts, and without increasing the cost of the installation. Whether these additions to the weight will be sufficient to keep the loss in the line the same as before, with the reduced pressure, will obviously depend upon the distance to which the power is to be transmitted, and in the following Table (p. 408) the effect of distance is made clear.

Taking the figures for 1 mile, and adding to them the cost of transformers as already found, it will be seen that 1,000 volts gives for this distance the lowest cost. Doing the same with the 2-mile figures we have almost a tie between 2,000 and 5,000 volts, 1,000 is out of it; 5,000 has slightly the advantage, though it has always the advantage beyond 2 miles. With the same sizes of motors suppose the power to be increased to 600 h.-p. and what happens? Here the cost of transformers and also the cost of the copper is doubled for the same per-centage loss in the line, the result being that the increase from 2,000 to 5,000 should be made in both cases for the same distance from the generator. It is interesting to note from the Table the distance at which it pays to step the pressure up to 10,000 volts. The step-up transformers would cost at 50s. per h.-p., £750, and adding this to the cost of the line for 10,000 volts at a distance of 10 miles it will be observed that the figure comes to £1,060 against £1,240 for 5,000 volts without stepping up. It therefore appears that when the distance approaches 10 miles step-up transformers must be resorted to.

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[*] This allows for a power factor of ·75.

Cost of Line Wire to Transmit 300 *h.-p. to various Distances at various Pressures. Two-phase System. Copper,* £65 *per ton. Power lost in line* 10 *per cent.* = 30 *h.-p.*

Volts.	1 Mile.	2 Miles.	5 Miles.	10 Miles.	20 Miles.	50 Miles.
	£	£	£	£	£	£
1,000	310	1,240	7,750	..	..	..
2,000	77·5	310	1,937	7,750	..	..
3,000	34·4	137	861	3,444	13,776	..
5,000	12·4	49·6	310	1,240	4,960	31,000
10,000	..	..	77·5	310	1,240	7,750

It will be evident from what has gone before that the pressure to be adopted is decided by the distance, by the way in which the power is to be broken up at the receiving end, and by the loss permissible in the line. In the example given I have merely indicated roughly how the engineer has to consider the matter before he can arrive at a decision. The copper and transformers are the chief items, and the rates for these may vary from the figures given, while needless to remark there is a host of minor factors which also have to be taken into account, and the influence of which cannot be neglected. It must not be thought that 10,000 volts is the limit of line pressure, though at the moment it is the exception. The pressure on the Hockfelden-Oerlikon line for the transmission of 900 horse-power for 25 miles is 13,000 volts, while the Ogden-Salt Lake line is to be worked at 15,000 volts. For the Niagara-Buffalo line, which is 25 miles long, the pressure will be 20,000 volts; while if currents from Niagara ever reach Albany, over 300 miles, in all probability they will have to be transmitted at a pressure of something over 50,000 volts.

Let us suppose that the pressure is decided upon, the Table which follows gives the current in amperes per brake horse-power necessary to be transmitted. The pressure is, in all cases, taken at the motor end of the line, the pressure at the generator having to be higher by such amount as corresponds to the loss in the line. The current is for h.-p. actually recoverable at the pulleys of the motors, it being assumed that the efficiency is about 90 per cent., and the power factor ·75.

TABLE I.

Current required per B.H.P. at various pressures.

Pressure in volts.	Amperes.
220	5·0
440	2·5
1,000	1·11
2,000	·55
3,000	·37
5,000	·222
10,000	·111

These figures are only to be taken as approximate. In the case of two-phases, half the above current flows in each circuit. For three-phases, the pressure in the Table would apply to the difference of potentials between the common junction of the three conductors and either of the lines, and one-third of the current given in the Table would flow in each wire.

The current being ascertained, the volts which it is permissible to lose in the line will determine the size of the conductors. In Table II. are given the volts lost in the conductors per mile of transmission for different current densities, and from this, knowing the fall of pressure allowable, the best density to work at can be determined.

If the plant is three-phase the volts lost per mile must be taken as half of what is given in Table II. Table III. furnishes us with the size of conductor for carrying any current at any density and thus supplies the final figure for the line

TABLE II.

Volts lost per mile at different current densities.

Amperes per square inch of section of conductor.	Loss of Pressure in Volts per mile.
2,000	172
1,500	130
1,000	86
800	69
700	60
600	52
500	43
400	34
300	26
200	17·2

In giving these figures I have simplified matters by ignoring the effects of the self and mutual induction of the line wires, but it must be understood that these are, in many cases, by no means negligible, especially in long distances with heavy conductors.

I have spent so much time on the line that there remains but little more for the motors. In concluding this section, I must just say that in no case should the conductor be less than No. 10 guage, on account of the liability of smaller wire to get damaged by storms, while practical considerations place the other limit at about $\frac{37}{15}$'s stranded. If a greater area is required it should be divided between two or more conductors. With this size of cable by two-phases, under ordinary circumstances about 1,500 horse-power may be transmitted.

TABLE III.

Size of Conductor required for Various Currents.

Gauge, S.W.G.	Diameter Inches.	Sectional Area. Square inches.	Resistance in ohms. per mile at 60° F.	Weight lbs. per mile.	Amperes which the Conductors will carry at a Current Density of									
					2000 amps. per sq. in.	1500 amps. per sq. in.	1000 amps. per sq. in.	800 amps. per sq. in.	700 amps. per sq. in.	600 amps. per sq. in.	500 amps. per sq. in.	400 amps. per sq. in.	300 amps. per sq. in.	200 amps. per sq. in.
37/15	·504	·1541	·2892	3142·	308·	231·	154·	123·	108·	92·5	77·0	61·6	46·2	30·8
19/13	·460	·1282	·3462	2625·	256·	192·	128·	102·	89·7	76·9	64·1	51·3	38·5	25·6
37/16	·448	·1219	·3661	2482·	244·	183·	122·	97·5	85·3	73·1	60·9	48·8	36·6	24·4
19/14	·400	·0973	·4579	1985·	195·	146·	97·3	77·8	68·1	58·4	48·6	38·9	29·2	19·5
0	·324	·0824	·5223	1678·	165·	123·	82·4	65·9	57·7	49·4	41·2	32·9	24·7	16·5
19/15	·360	·0789	·5652	1608·	157·	118·	78·9	63·1	55·2	47·3	39·4	31·5	23·7	15·8
1	·300	·0707	·6092	1438·	141·	106·	70·7	56·6	49·5	42·4	35·3	28·3	21·2	14·1
19/16	·320	·0624	·7154	1270·	125·	93·6	62·4	49·9	43·7	37·4	31·2	24·9	18·7	12·5
2	·276	·0598	·7197	1217·	119·	89·7	59·8	47·8	41·9	35·9	29·9	23·9	17·9	12·0
3	·252	·0499	·8633	1015·	99·8	74·8	49·9	39·9	34·9	29·9	24·9	19·9	15·0	10·0
19/17	·280	·0479	·9300	973·	95·8	74·8	47·9	38·3	33·5	28·7	23·9	19·2	14·4	9·6
4	·232	·0423	1·0186	860·	84·6	63·4	42·3	33·8	29·6	25·4	21·1	16·9	12·7	8·5
7/14	·140	·0356	1·253	727·	71·2	53·4	35·6	28·5	24·9	21·4	17·8	14·2	10·7	7·1
5	·212	·9353	1·253	718·	70·6	52·9	35·3	28·2	24·7	21·2	17·6	14·1	10·6	7·0
19/18	·240	·0349	1·271	715·	69·8	52·3	34·9	27·9	24·4	20·9	17·4	13·9	10·5	7·0
6	·192	·0289	1·487	589·	57·8	43·3	28·9	23·1	20·2	17·3	14·4	11·5	8·7	5·8
7/15	·216	·0289	1·543	589·	57·8	43·3	28·9	23·1	20·2	17·3	14·4	11·5	8·7	5·8
7	·176	·0243	1·770	495·	48·6	36·4	24·3	19·4	17·0	14·6	12·1	9·7	7·3	4·9
19/19	·200	·0243	1·831	496·	41·6	36·4	24·3	19·4	17·0	14·6	12·1	9·7	7·3	4·9
7/16	·192	·0229	1·953	465·	45·8	34·3	22·9	18·3	16·0	13·7	11·4	9·1	6·9	4·6
8	·160	·0201	2·142	409·	40·2	30·1	20·1	16·1	14·1	12·1	10·0	8·0	6·0	4·0
19/20	·180	·0198	2·261	402·	39·6	29·7	19·8	15·8	13·9	11·9	9·9	7·9	5·9	4·0
7/17	·168	·0174	2·552	356·	34·8	26·1	17·4	13·9	12·2	10·4	8·7	6·9	5·2	3·5
9	·144	·0162	2·664	331·	32·4	24·3	16·2	12·9	11·3	9·7	8·1	6·5	4·9	3·2
10	·128	·0128	3·346	262·	25·6	19·2	12·8	10·2	9·0	7·7	6·4	5·1	3·8	2·6

III.—MOTORS.

On referring to the classification at the beginning of this paper it will seen that there are two types of motors, synchronous and non-synchronous, and in their action these in several important particulars are unlike. I set down below in parallel columns the chief points of difference, thus :—

	Synchronous.	*Non-Synchronous.*
1.	Requires direct current exciter and has consequently a direct current commutator.	Does not require exciter and has therefore no commutator.
2.	Will only start with fraction of load.	Will start with full load with two or three phases.
3.	Runs always at same speed.	Speed drops as the load is increased.
4.	Has a power factor at full load of nearly unity.	Has a power factor at full load of from ·65 to ·85 according to size.

The first point is that synchronous motors require exciters. Such motors, as you are probably aware, are constructed on the same lines as alternators, whether for single, two or three-phase currents; in fact, they are alternators running as motors instead of generators. They must therefore have a direct current machine to excite their field magnets, and this means a commutator as well as a pair of contact rings to keep in repair. The non-synchronous motor on the other hand requires no exciter, the E.M.F. in the armature windings being induced by the action of the oscillating or rotating field. On this account non-synchronous motors are more often styled "induction" motors. Being without exciter there is no commutator to keep in repair, though in the case of large size motors contact rings are sometimes used for the purpose of putting resistance into the armature circuit.

The next point is the starting. To do work a synchronous motor must run in step with the generator, and until it attains a speed such that its frequency corresponds with that of the generator; in other words, until synchronising speed is obtained it is not in a condition to take the load. To run the motor up to speed various plans have been adopted. The exciter furnishes us probably with the most simple means of starting a single phase motor. Though giving a direct current, the exciter will of course run as a motor if supplied with an alternating current, provided its field magnets are properly laminated. To start the synchronous motor, all we have to do then is to first turn the alternating current on to the exciter to get the speed up, then when it is obtained switch it on to the alternator, by the same action altering the connections so that the exciter afterwards performs the function of energising the field. Here I wish you to notice that though the synchronous motor will do no work by itself until it gets into synchronism with the generator, there is no reason why the motor and exciter combined should not do some work. It depends upon the size of the exciter and what margin of power it has beyond driving the alternator up to speed. Another plan is to combine with the exciter a set of secondary cells so that the energy necessary to start the motor by direct current is always available. During working hours the exciter is charging the battery. Polyphase synchronous motors can be started by a small induction motor provided for the purpose, or they may be designed so that currents induced in the field magnet by the action of the rotating armature field will pull the speed up to synchronism. Such currents might be generated in the masses of an unlaminated field magnet, or in copper loops properly disposed on the magnets. Of course, the combining of a secondary battery with the exciter works as well in the case of polyphase as single phase motors, and no further starting gear is requisite.

But induction motors have this advantage over synchronous motors, that they will start without any trouble at full torque. There are many notable instances of power transmission schemes being successfully operated by synchronous motors and with single phase currents, but the system lacks range and flexibility. If the whole of the power is to be given up by a single motor or group of motors at the delivery end of the line, single phase transmission with synchronous motors is, perhaps, as simple and reliable as any, but if the power has to be divided amongst a number of motors of various sizes, situated at different parts, and each requiring to be capable of starting against a load without extraneous assistance, single-phase working is no longer suitable. Under these circumstances, induction motors fulfil best the requirements of power distribution, and the attribute which singles them out as superior to other types is that they start without trouble, and, in starting, exert great effort. Polyphase working becomes necessary for them, as only with currents of more than one phase have the starting difficulties been entirely got over.

With regard to constancy of speed, the synchronous motor has the advantage, as it runs absolutely in synchronism with the generator, but there are few cases in which the variation in speed between no load and full load in properly designed induction motors cannot be permitted. Again, though in the matter of power factor the synchronous motor has the advantage, there is no doubt that for general work, taken all round, the induction motor is much superior, its great starting effort and extreme simplicity easily outweighing what advantages are possessed by motors of the synchronous class.

The chief qualities which should characterise a good polyphase induction motor, are these:

1. The speed should vary as little as possible with change of load.

2. The effort exerted at starting should be large, and that without drawing an excessive current from the line.

3. The efficiency, *i.e.*, the ratio of power given out to power put in, should be high.

4. The light load current should be as small as possible compared with the full load current.

5. The power factor should be as large as possible.

6. It should stand over-loading to a considerable extent without pulling up.

Great attention has been bestowed on these points by several designers. As regards the first, the increase in speed due to throwing off all the load does not in well-designed motors of large size exceed 3 per cent. with constant voltage supply, while in the case of small motors it is only 6 per cent. A 100 h.-p. motor would comply with the former figure, while a 5 h.-p. would about comply with the latter. With respect to uniformity of speed, it will be observed that polyphase induction motors are quite on a par with the best direct-current motors. In both the speed is of course reduced when loaded by just such amount as will permit the current necessary to balance the load to flow through the armature.

As regards the second point it is important that the current drawn from the lines be not too great at starting. For small motors up to 5 or 6 h.-p. a short-circuited rotor, or squirrel cage winding as it is sometimes called, is only necessary, the excess of current at starting in the majority of cases not making much difference to the total current flowing. Such a rotor has an extremely small resistance, and when at rest it is to all intents and purposes the equivalent of a transformer with a short-circuited secondary. It would, consequently, never do for large motors to have such armatures on account of the enormous currents which would flow through the conductors and the correspondingly large currents drawn from the line at starting. When we come to sizes above 8 or 10 horse-power the armature bars are generally grouped in such a manner as to allow of a resistance being inserted into the rotor circuit at starting in much the same way as a resistance is inserted in the armature circuit of a direct current motor. For this purpose the conductors are arranged in series of three, and are connected starwise to a common junction, with their free ends brought to three insulated rings on the shaft. This is supplemented by a set of three resistance coils, also connected starwise, and with their free ends terminating in brushes resting in the insulating rings. The resistances are provided with a regulating switch operating all three branches at the same time, and thus the resistance inserted in the armature circuit at starting can be gradually taken out as the motor gets up speed. Apart from the resistance preventing an excess of current at starting, it has also the effect of increasing the starting torque, as excessive currents flowing in the rotor conductors weaken the resultant field and throw it out of phase with the currents in the rotor bars. By using a resistance in this way then we can start against full running torque without drawing more than the normal running current from the line, while with twice the normal current we can get twice the torque. Here again the reduction motor is quite on all fours with direct current motors.

The efficiency of polyphase motors, the third point referred to, is about the same as that of direct current motors. The following figures give some idea of the efficiency which makers are prepared to guarantee for various sizes at the usual speeds and frequency:—

	Efficiency per cent.
1½ h.-p.	76
4 ,,	80
5 ,,	80
12 ,,	84
15 ,,	88
50 ,,	91
110 ,,	92

I now come to a point which is of considerable importance and that is the power factor or ratio of actual watts to apparent watts given to the motors. I have already spoken of motors behaving to some extent like choking coils, and it will be obvious that running light, a motor is nothing more than a transformer running on open circuit, a transformer, too, with an air gap in its magnetic circuit and requiring a large magnetising current relatively to the bulk of iron it contains. Now in this kind of transformer the apparent watts (or product of current and difference of potentials) given to it are very different from the real watts, and in a polyphase induction motor say of 50 h.-p., the former may be as an ordinary thing when running light ten times as great as the latter. It results, therefore, that the current flowing in the circuit when the motor is running without load is comparatively large, and it actually reaches from 20 to 30 per cent. of the full load current. This current lags behind the impressed E.M.F. and does not indicate that the efficiency of the motor is low; it may, in fact, be analysed and regarded as two separate currents, one of which is pushed forward until it is in phase with the E.M.F., while the other is pushed backward until it lags 90° behind the E.M.F. The product of the first current and impressed E.M.F. gives the watts actually put into the motor, the second being 90° out of phase with the E.M.F. is a "wattless" or "idle" current. So much then for the power factor of motors running light.

The idle current just referred to has to be supplied whether the motor is running light or loaded, but an addition is made to it as the load is put on. This arises from the fact that the field to which the current in the rotor bars is due, is the resultant of the primary field impressed on the stator, and the cross field produced by the rotor current itself. The rotor currents, and with them the currents in the line, are thus caused to lag behind the impressed E.M.F., with the result that the idle current is largely increased. This does not mean that when loaded the power factor diminishes, for though then the idle current is larger, the proportion of the useful current to the idle current is much greater, the power factor rising in consequence. The power factor depends largely on the size of the motor, and below are figures which may reasonably be expected from motors of different sizes :—

H.P.	Power Factor.
1½	·65
4	·70
5	·72
12	·75
15	·78
50	·80
110	·82

These figures accord with the results given by actual tests, and you will be much less likely to be disappointed if you assume them as correct than if you take those given by most makers. They clearly indicate, as I have mentioned before, the necessity for rating the size of generators and transformers at not less than one kilowatt per horse-power.

I hope the desirability of getting a power factor as large as possible will be apparent, though I am sorry to say the efforts of designers in this direction have not been always appreciated. In an article which appeared in the *Electrician* last summer, for instance, Professor Silvanus Thompson regarded it as "a piece of superstition" to demand anything higher for a small three-quarter horse-power single phase motor than a power factor of ·49! and went on to say that as the efficiency was 90 per cent., he should not mind if the power factor were smaller. In that article the Professor inveighing against "the pedantic demand for a high power factor" made the mistake of supposing that he was voicing the opinions of practical men, the very men be it observed who, fully conscious of the advantages which an increased power factor would confer, have been most persistently doing their utmost to raise it. This is indeed a very practical question. If the current were in phase with the E.M.F., that is to say, if the power factor were 1 instead of averaging ·75, it would mean that the generators would require to be only three-fourths of the size we have now to make them, that the lines would only require three-fourths of the copper they now have, and that the transformers would only require to have three-fourths of their present capacity. The regulation would require less attention, and the regulating gear would be less costly. Notwithstanding that these advantages would accrue, we are told that the demand for a high power factor is a superstition. Why anyone should hold such an opinion I do not know. Probably it arises from the difference in ideas induced by theorising about power plant on the one hand, and employing it practically on the other.

The lag of the current has not, however, led to much difficulty in working, and it is chiefly on account of the saving in outlay which would result that we should like to see the power factor higher. To some extent the difference in phase between the current and E.M.F. can be compensated by the use of over-excited synchronous motors, these tending to make the current lead instead of lag. A few synchronous motors, taking a fair proportion of the load, make a very perceptible difference to the power factor, and where the circumstances permit, there is rather an advantage in introducing them into the circuits. The Stanley Manufacturing Company, of America, supply with each of their two-phase motors as a usual thing, a couple of condensers, which supply the idle currents to the motors. One of these is connected in parallel with each of the field circuits and has a capacity such that the amperes at the working voltage equals the no load current of each field. If there is no distortion of the current wave the apparent energy taken by the motor is equal to the real energy, and the power factor is therefore very nearly unity. The Stanley Company is the only company manufacturing condensers as part and parcel of power plant equipment, though I believe the idea was rather to enable their motors to run satisfactorily at high frequencies, than to increase the power factor at low ones.

I have now come to the end of my discourse, but with many sins of omission on my head. Though I have been able to deal, in a measure, with the principal factors in transmission of power work, I feel how inadequate have been my efforts to cover so large a field in such a short time. The points to be observed in the construction of transformers for power work I have not been able to touch. Discussion of these would take up a considerable amount of time, as would also the descriptions of switching arrangements in use. Again, there is the question as to whether, for polyphase working, the advantage lies with two-phase or three-phase transmission, a question which cannot be argued at length here. The three-phase system, as we have seen, enables some copper to be saved in lines, but this is practically the sole advantage, and it must be remembered that only when the distance exceeds 25 miles, does the saving in copper over the two-phase system figure up to anything like 5 per cent. on the total cost of the scheme. Considering the simplicity of the two-phase system, and the ease with which it can be worked, as compared with three-phase, especially where lighting is combined with power, it seems that the saving in copper is so small a fraction of the whole cost as not to be worth considering. The difficulty due to uneven loading of the circuits in three-phase working is particularly objectionable, and it must be remembered that not only have the currents to be balanced in the three branches but the kind of load must be similar; it will not do to have an inductive load on one branch and non-inductive loads on the others. To get over this difficulty in a general system of distribution by three-phases a fourth conductor has to be used as a balancing wire or common return, so that in the end as many conductors are required as for the two-phase system. For the transmission of power only in large units the three-phase system is all right, but where lighting is combined with power two-phase is always preferable. In the latter the circuits are not electrically interlinked in the generator armatures, and as a consequence the regulation of the E.M.F. on the lines is much more satisfactory, and can be carried out without expensive and complicated gear. In fact the two-phase system, with all the simplicity and ease of control of single-phase, possesses all the important advantages of three-phases.

DISCUSSION.

Mr. A. T. SNELL regretted that not having had the opportunity of seeing the paper in print, he was not in a position to discuss it, interesting as it was. the author seemed to have taken up the subject at the point where Mr. Kapp left it, and to have brought it down to the present time, and though he had had to omit much, he had referred to the most salient points in connection with generators, line, and motors. On the latter branch of the subject he believed several experiments had recently been made on polyphase and single phase motors, and he hoped someone would be able to state the results.

Mr. W. M. MORDEY said he was sorry not to be able to speak from experience with regard to polyphase motors. There was a great difficulty in discussing papers of this kind, resembling the multiplication table in absolute truth. He was glad Mr. Esson had alluded to the vexed question of a standard frequency, and he wished some arrangement could be made by which a standard could be fixed. It was impossible to decide on an absolutely best frequency, as there was no such thing for all purposes, but they might decide on one which would be best for all electrical engineers, simply because it would be standard. Then Mr. Esson referred to the question of sine, as against saw-toothed curves, and seemed to express a preference for the latter under some conditions. It was said that Nature abhorred a vacuum, and he believed Nature abhorred saw-toothed curves, and that it did not much matter what they made the curve, because Nature would take care of it afterwards. He drew attention to the fact that nearly all published experiments on the forms of curves had been made at electrical colleges, on machines running light; none, or few, were made under the working conditions which obtained on distribution systems. A curve might be saw-shaped to begin with, but when you considered everything that took place in the way of self-induction, in the fact that machines were running in parallel, that there were motors, arc lamps on the circuits, and so on, he believed that it would usually be found very little of the form of the original curve would be left. He would recommend gentlemen who had experimental facilities, and were fond of experimenting on the shape of waves, to try and induce some central station engineers to let them experiment in the first place on the form of wave with a light running machine, no load and no other machine running parallel, and then on the circuits supplied by the same machines under full load conditions, particularly if they could do this on a system where there were motors on the circuit. He agreed as to the desirability of getting alternators to give a good "characteristic," but he could not agree with the author's remark that for power work, where a good regulating machine was required, single wound field magnets were not as much used as separate magnets. He believed that on the Continent, where far more power was used than here, single wound magnets were used, and it was a mistake to suppose they were not as good regulators as machines wound with separate magnets. He thought the contrary was the case. He would like to show the author such a machine, which had a drop of not more than one-fourth that mentioned in the paper. With regard to insulators, he might mention a plan which he had found very useful for testing the insulation of porcelain, so that imperfect insulators might be weeded out before use. The insulators should be turned upside down in a tray of water, and the cups filled with water, and in each should be hung a little bit of copper wire connected with one terminal of a dynamo, the other terminal being joined to the tray. After running a few hours, the water in the faulty insulators would be, more or less, coloured blue, according to the amount of leakage through the insulator, which caused a formation of copper salt. Those which showed no colouration could be safely used.

The CHAIRMAN said the subject of alternating current motors really deserved much more discussion than gentlemen present seemed disposed to give it. It was, in his opinion, still an open question whether the continuous current motor had been absolutely displaced, whether the great move in favour of alternating current was going to last, and whether Mr. Kapp's declaration that alternate current working would form the ultimate solution of the problem how to transmit power over great distances was correct. Perhaps it was hardly appropriate to the paper to say anything about continuous current motors, but he wanted, at least, to utter a warning that it must not yet be accepted as an axiom that the transmission of power to a distance was impossible with continuous currents. He was rather disappointed that Mr. Esson had not described the monocycle motor, which was said to be an ingenious combination of the single-phase and three-phase system. There were indications in the paper that the transmission of power by alternating currents was not altogether so easy and straightforward as some might think. It was stated, for instance, that the conditions under which they had to work were extremely trying. You had to make rather a complicated arrangement of coils in the machine, and to use three or four wires, and step-up and step-down transformers, all of which were not very conductive to smooth working in practice. What decided the success of a system was the ease with which it could be worked. Most great inventions commenced by being very complicated, and were gradually simplified until you almost wondered why the complicated thing was invented first. When, therefore, he met with any system which was complicated, he distrusted it, and thought it could not be right. Another difficulty to which Mr. Esson called attention was the power-factor, which averaged ·75, instead of unity as in the case of the continuous current. If the power-factor could be increased to unity, generators would only require to be three-quarter the size, and lines would only take three-fourths the copper; but even then there would be the transformers which in the continuous current were not required. All this indicated that alternating current motors had not got it all their own way, and, in his view, the simplicity of the continuous current indicated that it would yet prove to be the right solution of the problem. However, without any further criticism of the system, he would propose a hearty vote of thanks to Mr. Esson for the very able and thorough manner in which he had brought the subject before them.

Mr. A. W. MARSHALL said he gathered from the paper that the speed of the motor decreased when the load came on; but he did not understand whether there was any means of regulating or altering the speed if desired.

The vote of thanks having been carried,

Mr. ESSON, in reply, said he had written a description of the monocyclic system, but had to strike it out owing to the paper being too long already. It was really a most interesting system, but he feared it would not come into general use in this country. With regard to continuous current *versus* alternating current motors, they all knew that the Chairman was in favour of the former, for what reason he knew not; but the fact was that large powers had been transmitted to long distances by alternating currents, and as yet it had not been accompanied with continuous currents. All Mr. Siemens had to do was to show how it could be done; he would not say it could not be done, but it had not been done yet. The continuous current plants used were for comparatively small powers and short distances. It was, perhaps, unfortunate that there was a power-factor to be considered, but still it had not prevented the system being a success. He concluded by inviting those interested to inspect two very interesting motors kindly lent him by Messrs. Langdon, Davis and Co., and the Motor Company, Limited; one a non-synchronous, self-starting motor, the other a synchronous, self-starting motor, each suitable for working with a single-phase lighting system.

The CHAIRMAN said his firm had executed some of the largest power transmission works with three-phase and two-phase currents, so that he knew something about them; but he was still of the deliberate opinion that the continuous current was the best.

Mr. GRAHAM HARRIS said he had been engaged in very many cases of transmission of power by the alternating current, but after a good deal of consideration extending over some years, he was inclined to agree with the Chairman that the alternating current had not as yet proved its superiority.

Miscellaneous.

COMMERCIAL SCHOOLS IN RUSSIA.

Russian manufacturers, merchants, and business men in general, appear now to be of one opinion, that a knowledge of commercial sciences is getting to be more and more important for commercial affairs, and in that respect that they are, especially in Southern Russia, far behind some of the other countries. The Consul-General for the United States at St. Petersburg says that there is not one Russian exporting firm in any of the ports of the Black Sea, or the Sea of Azov—in fact, the whole business in Southern Russia is in the hands of foreigners, and the reason is that Russia has not enough persons with commercial education. They have come, therefore, to the conclusion that the present state of Russian trade and industry requires commercial and trade schools in the south of Russia. During the last two years many schools have been founded, and at present a number of new schools are being planned, all to be established and supported by commercial societies, towns, and private companies. According to a new law for commercial education, they will be permitted not only to supervise the management of school affairs, but also to take part in their practical direction. In Kiev the merchants raised the capital for a commercial high school of seven classes, and for a three class industrial school. In Kharkov trade schools are being established, and in Simbrisk a Commission of commercial delegates is working at regulations for a commercial school of three classes. Movements for establishing commercial schools of different types in Moscow, Yaroslov, Kazan, Tiflis, Archangel, Odessa, Rybinsk, Nijni Novgorod, and Kashin have already been started. In the City of St. Petersburg a society has been organised for the purpose of promoting commercial education, and among the founders of the society are the richest and most influential merchants. In Ekaterinoslav and Taganrog it is proposed to establish commercial schools. In Nikolaev it has been decided to organise for the time being a commercial school in which the foreign languages will be taught, the course of studies to be increased in the future. Trade classes for commercial clerks will also be opened there. The means for the maintenance of these schools will be raised partly by the municipalities, and partly by the representatives of commerce and industry.

PORCELAIN INDUSTRY IN GERMANY.

The porcelain industry in Germany has of recent years exhibited a marked development. In addition to the State factories at Berlin and Meissen (Saxony), there are many private establishments which are devoted to the supply of ordinary consumption, and the serious competition that the latter have to contend against, has obliged them to turn out articles distinguished by an ever-increasing variety of design and perfection of manufacture. According to M. Soulange-Bodin, French chargé d'affaires at Berlin, the German public could only find, at one time, high class porcelain among foreign imports, and more particularly imports from France, but at the present time articles of German manufacture are found everywhere, and frequently on the French markets. In 1880, the exports of German porcelain only amounted to 66,830 quintaux, while fifteen years later they exceeded 201,000 quintaux. During the last ten years, exports have more than doubled, and their value now is about 20,000,000 marks (£1,000,000). The principal markets are the United States, England and her colonies. After these countries come Holland, Switzerland, Austria-Hungary, France, Belgium, the Scandinavian countries, Chili, Argentina, and Brazil. The porcelain industry is rapidly growing in importance, and the exports for the first three months of the present year amounted to 43,000 quintaux, as compared with 34,000 during the corresponding period of 1895.

Correspondence.

SLAVERY IN NORTHERN INDIA.

The quotations made by Sir Alfred Lyall, more or less inaccurately, from the Parliamentary Return to an Order of the House of Commons of the 22nd of April, 1841, on "Slavery in the East Indies," and published in our *Journal* of the 19th inst., when examined with the context, do not justify his denial in the discussion on Mr. Lee-Warner's paper, published in the *Journal* of the 5th of February last, of the existence at any time of the domestic slavery of the worst kind in Northern India; while taken with the context, and interpreted by the whole body of evidence given in the Return from which Sir Alfred quotes, and the Returns to the Addresses of the House of the 1st of March, 1838, and the 15th of February, 1841, and read in the light of the history of slavery in the Old World, they corroborate all that was advanced by Mr. Lee-Warner under this head of his subject.

In such works as Yanoski's "Esclavage Ancien, et sa transformation en Servitude du Moyen Age" (I quote from memory), Blair's "Slavery among the Romans," and Boeckh's "Public Economy of Athens," and from the researches of modern ethnologists, one learns that in the most primitive period of human history of which we have any surviving indications, when men were hunters, they did not enslave their vanquished enemies, but slew them outright; that in the next, or the pastoral stage of social evolution, they captured them, but to sell them for the most part,—the beginning of commercial slavery, keeping only a few of the men to do the rougher work of their nomad life, and the women with their young children,—the beginning of domestic slavery. But when these shepherds became so numerous and strong that they were able to make a conquest of the more fertile territories of richer neighbours, they reduced the whole of the conquered people to slavery. Our word slave, derived through the French *esclave*, German *slave* and Russian *slava* (literally the "glorious" one), refers to the Sclavonians reduced to servitude by the Teutonic races, who in their westward migration gradually dispossessed the former of the lands they had acquired beyond the Vistula up to the Rhine. Those thus overcome, became the absolute slaves of their masters, and had to provide food for them, and do all the hard labour required by them, and carry on all the industries that subserved their comparative ease and luxury. Every race of the Old World in settling down from a migratory to a sedentary condition of life, did so on the basis of the enslavement of the more highly civilised people they subjugated. This was the history of Asiatic slaves generally; and so greatly prized was slave labour of any artistic quality by the rulers of Babylonia and Assyria, that even when undertaking merely punitive expeditions against the nations around, they invariably, if successful, made a point of carrying off all the handicraftsmen they could lay hands on, and settling them somewhere within the borders of their archaic empires. This form of slavery was inherited by Greece and Rome; and the contempt in which the medical profession is instinctively held by our still feudal-minded aristocracy, is a lingering trace of its enslaved status down to the latest years of the Roman Empire. Only indeed among those nations of antiquity, in which the organisation of society took a theocratic form was slavery not the very foundation of the social system. Under the theocratic organisation of Brahminical India slavery, owing to the institution of castes, was unreservedly recognised: yet even there it was not vital to the social system, for where society is divided into castes, the slave is but another outcaste. This however led, in certain directions, to the comparative improvement of the condition of slaves among the Hindus of ancient India, while under the influence of the domestic slavery of the Mahometans the position of slaves generally was materially ameliorated. But never was Asiatic slavery in its worst forms marked by the horrors of the colonial slavery of England in the 17th and 18th centuries. The comparative benignity of the slavery of Rome, is shewn by the number of terms there used to discriminate between various kinds of slaves, such as, "servus," "verna," "famulus," "mancipium," "puer," "ancella," "vicarius," "mediastinus," &c. On the break-up of the Empire, and its redintegration into the states of mediæval Europe, each affording a refuge to malcontents from the others, and each requiring to defend itself against others, slavery as it had been established among the Romans was no longer possible, and Roman slavery gradually became mediæval serfdom, and then modern service. I have given the etymology of "slave." The Latin equivalent was "servus," from the accusative form, of which "servum," through the French *serf*, comes the English serf, and again, through the French *servir*, the English servant; and these three successively formed words, "servus" [= slave], serf, and servant, show the gradual modification in Central and Western Europe of Roman slavery from bondage, into serfdom, and free service. Now in India, at the time of our conquest of the country, there prevailed a condition of society in many ways closely resembling that of Central and Western Europe from the time of the Merovingians and Carlovingians, and of the Saxon and Franconian Emperors, to that of the Houses of Luxembourg, Hapsburg, Aragon, Burgundy, and Anjou, and down to the period of the maritime discoveries and depredations of the Spaniards and Portuguese, and Dutch and English; and it is just from this retrospective point of view, and not from a study of the colonial slavery of England—a damning blot on the page of human history—that we have to approach the subject of slavery in India, and to estimate the force of Sir Alfred Lyall's deliberately reiterated criticisms of Mr. Lee Warner's able and brilliant paper: a paper which, in so far as it deals with Indian slavery, is, in substance, simply a comprehensive, lucid, and absolutely fair and impartial *précis* of the Parliamentary "Returns" of 1st March, 1838 (615 pages, oblong quarto), 15th February, 1841, (278 pages), and 22nd April, 1841 (595 pages). Again, no one learned in the history of the abolition of slavery in the English colonies, and knowing how long it was adumbrated by our poets, philosophers, and economists,—Milton, Cowper, Beattie, Johnson, Adam Smith, Paley, &c., and anticipated in some of our dependencies, such as St. Helena, will be disposed to join Sir Alfred Lyall in cavilling at Mr. Lee-Warner's description of the Act of the 7th of April, 1843, as "epoch-making." If it was not, neither were the English Emancipation Act of the 25th of March, 1807, and Lincoln's proclamation of the 1st of January, and notification of the 18th December, 1862, "epoch-making" charters of humanity.

It is from the last of the three "Returns" cited that Sir Alfred Lyall exclusively quotes in support of opinions hastily formed by him in admitted ignorance of the publication of these Returns, and of there ever having been a Parliamentary inquiry into the existence of slavery of India.

The first quotation given from page 56 omits, without any indication of the omission, a sentence between the first and second sentences quoted, which entirely alters the significance of the first. The omitted sentence is:—"By lawful slave is meant of course an infidel who has fought against the faith, or the descent *(sic)* of a person of their class." It is scarcely necessary to observe that while Mahometan law recognises only these two classes of slaves, the Mahometans in practice acquire slaves by purchase, donation, and inheritance. The second quotation from page 74, to the effect that the right of a master over his slave had not been acknowledged in the courts of the Delhi territory for a number of years, is equally misleading; for Sir Alfred omits to follow the quotation by others from immediately subsequent paragraphs, stating that this was owing to a British officer, whose name, deserving of lasting honour, is not once mentioned, having, when in authority at Delhi in 1811, of his own responsibility and motion, abolished all forms of slavery within the limits of his jurisdiction. The third quotation from page 329, is also most carelessly transcribed, but not misleadingly; and, taken with the context, it entirely upholds Mr. Lee-Warner's summary. The exact words following the hiatus indicated by Sir Alfred in this quotation are:—"It is also generally acknowledged in practice that a slave, whether Hindoo or Mahomedan, can possess no property in his own right, and that whatever may fall to him by inheritance, gift, or otherwise, as well as everything that he may acquire by means of his own labour and exertions, becomes, and is necessarily, the property of his master." A second quotation, given as from the same page, is really from the previous page, and though the passage is reproduced with verbal omissions, modifications, and additions, these do not modify its tenor. But this sort of thing is not quotation, but paraphrase, The quotation from page 335 is again marked by verbal alterations, and without affecting the sense of the extract so quoted. But after the Sessions Judge of Zillah Goruckpur has stated that he could find only one case amongst the records of his court of a suit for the recovery of a slave [slave-girl], and that was dismissed, he goes on in the 5th paragraph of his reply to say:—"In Behar and Tirhoot domestic slavery prevails to a surprising extent. ....On examination of the registry books [Sarun division] I found one book entitled 'Ijaranamahs' [deeds of lease or tenure], which was solely set apart to the entry of indentures, binding an individual or a whole family, in most cases for a trifling consideration, to slavery or servitude for a period tantamount to perpetuity. I have a perfect recollection of an entry, in which an individual bound himself, his wife and children, and children's children, to servitude for a period of 99 years; the consideration was 19 rupees, and the purchaser or holder of the deed was a vakeel in the judges' Court." The quotation from page 344 is given *verbatim et literatim*, and is confirmed by the report of the officiating magistrate, Zillah Jounpoor, page 339:—"Slavery in the district, as far as I am aware, does not exist in its true acceptation." But the reports prove the prevalence of slavery in both districts. In the latter report Mr. Tulloh goes on to say:—"Some there I believe who are denominated slaves, *i.e.*, slave girls; but they, I have always understood, are looked upon as belonging to the family and are kindly treated." Mr. Neave, in his final paragraph, practically justifies slavery by purchase in case of starving people, only he would change the term "slavery" to "apprenticeship." This reminds one of the well known passage of Euripides (in Ion, 854):—"The one thing that is hard on a slave is his designation: in everything else he is as a freeborn man;" and again of a passage in Autiphanes:—"The slave deprived of his native country finds it again in a good master." Still for all its mitigations, and all these euphemisms, slavery remains slavery, justifying Homer's pertinent observation on it (Odyssey xvii., 322), "A man made a slave is unmade of half his manhood"; and Cicero's scathing reproach:—"There is nothing more detestable than dishonour, and nothing fouler than slavery." The quotation given literally from page 355 is to the same effect as the two previous ones; but the report, at 357, referred to as confirming the foregoing, does not so do in the unequivocal sense understood by Sir Alfred Lyall; for both reports are simply to the effect that the records of the Saharunpore and Meerut Courts afforded no instances of suits between slave girls and their owners: and for the explanation of this we must go back to the report at page 338 of the Magistrate of Ghazepore, para. 8: "The system (of slavery) would appear to be most prevalent in large towns and cities, where society being more refined, the value of personal service is far greater than in the less inhabited parts of the country; that it is altogether of a domestic character, bearing a close affinity to the relation of master and servant, or parent and child; *that slaves, being considered* *absolute hereditary property*, any act of the legislature, having for its object their emancipation, would be viewed by the masters as an interference with their private rights and interests, while . . . . the slaves, instead of being an oppressed race, are, generally speaking, better cared for and happier than any other class of domestic servants." In short, Indian slavery, and Asiatic slavery generally, was classical slavery, still further softened by the action on it of Mahometanism; and it had little in common with the infamous slavery of the Christian West.

In this connection I will quote, from the Return of the 15th February, 1841, pages 193, 194, the concluding paragraph of a letter of the 10th of January, 1878, from Mr. Hennell, then our acting Resident in the Persian Gulf, to Mr. John Pollard Willoughby, political secretary to the Government of Bombay. It is quoted by Mr. Hennell from a report of his predecessor, Captain McLeod, and is as follows:—"It is gratifying to humanity to know that slaves are not only extremely well treated and protected by their Arab masters, but that they even enjoy a very considerable degree of power and influence. I remarked that they were everywhere the stoutest and best fed men, and that they seemed happy and comfortable. I must not however omit to mention an exception which occurred at Bahrein (pearl fishery), where two slaves sought refuge on board the *Ternate*, from the cruelty as they said of their master. They were not however received, and we had no means of ascertaining the merits of the case. Much as it is to be desired that this horrid traffic should be abandoned throughout the world, we must, I fear, confess that the cruel treatment of the slaves has been the reproach rather of European than of Eastern nations." Indeed, one of the motives of the Indian Law Commissioners in advising the abolition of slavery in India was their fear, to their credit be it recorded, lest it should become greatly aggravated under our rule. Thus in their "Observations" on the evidence collected by them, they say, in the Return of the 22nd of April, 1841, at page 193:—"Before, however, we proceed to point out the mischiefs which arise out of slavery as it actually exists [in India], we wish to call the attention of Government to the probability, under existing circumstances, of a different class of mischiefs springing up. For although the hardships and oppressions endured by the West Indian and the American slaves have, generally speaking, no existence in India, it appears to us that now the country is open to the enterprise of *European capitalists*, if they are permitted to purchase and hold slaves, a system may gradually grow up not very dissimilar from that the abolition of which has cost the mother country so much money and so much trouble in the other hemisphere. A set of white masters working gangs of black slaves for profit, is an object which, after looking through the history of slavery in the West, we cannot contemplate without the strongest repugnance; and in proportion to that feeling, is the earnestness with which we would urge the Government to prevent, by timely interposition, the possibility of such an object being realised [in India]."

Sir Alfred Lyall's last quotation is from this very page. The "Observations" extend over thirty pages of close print, but he quotes only the casual words, suggested by this apparition of West Indian slavery, "the lawful nearly innocuous status of slavery in India"; and he argues from them that the Commissioners were evidently in doubt "whether it is worth abolishing, if it can be kept within its existing limits." It is a perplexing conclusion at which to arrive from even the briefest review of the Commissioners voluminous "Report" and "Observations," together extending over 200 pages; and in the course of which they enforce by an overwhelming mass of evidence, and in the strongest terms possible, the three great evils resulting from the universal practice of slavery in India; namely, the abuse of the power of punishment, the sale of free persons, and "the monstrous practice of the kidnapping of children."

They report that in the North-West Provinces slavery was chiefly confined to the towns, and was generally of a domestic character, which be it noted covers the infamous traffick in slave-girls; that over the whole sub-Himalayan region, from Cashmere to Assam, and into Arakan and Tennasserim, and throughout the Malayan Peninsula, slavery in its worst forms was everywhere common. That in Bengal one or other of the forms of slavery was imposed on nearly the whole labouring population. That in Western India, Canara and Malabar, and in Southern India, from end to end, the greater part of the agricultural population had been in absolute bondage from time immemorial. That only in three districts of the Madras Presidency was slavery unknown. And that in the Bombay Presidency, the slaves in the Southern Mahratta Country were generally agricultural labourers, but that in Gujerat, and other parts of the Presidency, they were generally domestics. In short, every paragraph of the Report, and of the evidence on which it is based, bears out the accuracy of Mr. Lee-Warner's abridgment of the Return, and the moderation of his reflections on the facts it reveals.

GEORGE BIRDWOOD.

22nd March, 1897.

PREVENTION OF FAMINE IN INDIA.

In his speech on Thursday last, the Chairman referred to the irrigation schemes which had been carried out in the province of Bengal as financial failures, that the people "reluctantly" availed themselves of the facilities which the works afforded them, thus conveying an impression to those present at the meeting, that the money expended thereon had not been beneficially laid out, and that the schemes were, in consequence, of little account as factors in the prevention of famines like the present calamity. As I am primarily responsible for the design and execution of these schemes, and for the general policy of irrigation works in Bengal during my tenure of office, I think it but fair that such a representation of them should not go abroad, through the medium of the Society's *Journal*, without showing what the irrigation works in the Bengal provinces of Orissa and Behar have actually effected. As I had no particulars with me on Thursday, I was unable to quote them at the meeting. I would therefore ask leave now to explain that, however much the works have fallen short in showing a balance on the credit side of the Government accounts as published, the last Official report for the year 1895-96, just received by me, contains the undermentioned results as summarised from the tabular statements which accompany it. I must commence by observing that both those large irrigation schemes must be considered as a whole, and not piecemeal as shown in the reports and the accounts, for they were both designed as comprehensive schemes, whose component sections are intimately connected and inter-dependent. The Orissa works had just been commenced when the great famine of 1864-65 desolated the whole of that province. The mortality among human beings reached the appalling figure of 750,000, while the destruction of cattle could not, I believe, be reckoned. In the year following the floods in all the Orissa rivers, especially in the Mahanuddy (the principal one), were excessive, and swept away the major part of the crops; so that the calamity in respect of food was intensified, and was of two years duration. The cost to the Government amounted to over £1,000,000 sterling, in addition to the loss of two years revenue, more or less, while the loss to the people in food, cattle, and homesteads was very much more. The Government alarmed, appointed a Commission (of which the late Sir George Campbell was President), who recommended a vigorous prosecution of the works, and when the East India Irrigation Company's resources proved unequal to the task, the Government purchased the works which they have since completed, though not to the full extent of the original design. During the ten subsequent years in which I was first Chief Engineer in the Irrigation Department in Bengal, and, subsequently, Inspector General with the Government of India, there were three if not four years, during which owing to the uneven distribution of the rainfall, there were apprehensions of scarcity and high prices, but they were happily warded off by the relief of timely irrigation and by the facilities which the canals afforded for the transport of grain. During the present famine nothing has been heard of suffering in Orissa, though to my surprise there was a tract on the coast-line faintly tinted on the map which illustrated Sir Charles Elliott's paper, and which signified that that particular portion of the province was slightly affected. A gentleman who had lately come from Orissa happened to attend the meeting, and on my asking him whether there was really any scarcity in Orissa, he replied there was no lack of food but that there were high prices owing to the quantity of grain which was being exported from the province, hence in this year of far greater calamity, Orissa, instead of requiring a million sterling to be spent in a vain endeavour to keep its population alive, is probably receiving that amount in return for the produce she is exporting to feed other localities, but this receipt will not appear on the credit side of the Public Works accounts, any more than the saving of the recurrence of expenditure on relief since the year 1864-65 has been considered any set-off against the capital outlay. That saving, however, is not the only benefit secured to the Government. The people of the province have prospered greatly, as is evident from the continual increase in the exports and imports since the canals reached the ports—a prosperity in which the Government cannot fail to have indirectly, though not the less substantially, shared. The proprietors of the landed estates, however, have not been slow to appropriate their share of the benefits from their tenants, but have added considerably to their incomes. The province of Orissa has now, by means of the various canals, been placed in direct communication with all the ports on the coast as well as with Calcutta, and consequently the traffic on the canals, as will be seen, is already very large and is annually increasing, a fact on which the Chief Engineer in Bengal remarks:—"The development of traffic on the canals, exhibited by the largely increased revenue from navigation, is very gratifying. The increase was contributed by all the canals with the exception of the Nadia rivers," which latter are effluents from the Ganges unconnected with the Delta works. Of course there will be variations in the areas irrigated from year to year according to the seasons of favourable or unfavourable rains. A total, however, of nearly 600,000 acres irrigated in a year of favourable rainfall, yielding a produce of, at least, about 500,000 tons of food grains, valued at nearly £2,000,000 sterling, and in a calamitous year, like the present, at probably double that amount, would not generally be considered a small factor as a protective measure against famine.

RESULTS FROM THE ORISSA SCHEME IN THE YEAR 1895-96.

Irrigation.

The total area irrigated in a year of *favourable* rains, in round numbers amounts to	189,000 acres.
(Against 262,000 acres in a *deficient* year.)	
The area protected, which in former years was all liable to be swamped by floods	970,845 ,,
Value of the crops on the irrigated area only	4,700,000 Rs.
Value of those protected from floods	20,340,000 ,,

Navigation over a length of 500 *miles.*

Number of boats carrying cargo ..	68,334
Tonnage ,, ,, ,, ,, ..	1,153,844 tons.
Ton mileage	29,896,240
Value of cargo moved	29,154,670 Rs.
Timber	736,000 c. ft.
Value of timber	244,436 Rs.

The receipts for 1895-96 have been :—

	Rs.
From Irrigation............	328,760
,, Navigation	461,000
,, Miscellaneous	49,780
Total..........	839,870

The otal receipts, it will be thus seen, are but one-sixth per cent. of the value of the irrigated crops only, while the revenue raised from the irrigated area is but one-fourteenth per cent. of that value!

RESULTS FROM THE SONE SCHEME IN 1895-96.

Irrigation.

Total area irrigated in a year of *favourable* rain	395,322 acres.
(As against 474,723 acres in *deficient* years.)	
Estimated value of irrigated crops	13,200,000 Rs.

Navigation over 218 *miles of canal.*

Number of boats, including empties	5,838
Tonnage	78,478 tons.
Ton mileage....................	4,530,000
Value of cargo moved	4,736,000 Rs.
Timber and rafts................	2,676,932 c. ft.
Value of timber and rafts........	268,430 Rs.

Total Receipts.

	Rs.
From Irrigation............	783,920
,, Navigation	60,917
,, Miscellaneous	33,148
Total..........	877,985

One-fifteenth per cent. on the value of the irrigated crops only!

Total irrigated areas in both schemes.

In a year of favourable rains	584,322	Acres.
In a year of deficient ,, ...	736,723	,,

Total Traffic on both schemes.

Number of boats	74,174
Tonnage	1,232,322 tons.
Ton mileage	34,427,090
Value of cargo moved	33,891,228 Rs.
Timber	3,413,332 c. ft.
Value of timber	552,866 Rs.

Total Receipts from both schemes.

	Rs.
From Irrigation	1,112,688
,, Navigation..........	522,247
,, Miscellaneous	82,928
	1,717,863

Or only *one-sixteenth* per cent. on 17,900,000 Rs. on the value of irrigated crops alone.

In the face of the above figures is it a fair representation to say that the works have failed to benefit the country, or that the people "reluctantly take advantage" of them? With whom does the fault lie, that two schemes of works which have thus been so largely and so beneficially utilised by the community should not have yielded a larger *direct* revenue to the Government Treasury? Would any great landlord in any country consider such results on his estates as failures or have been at a loss to adopt measures for securing adequate returns for such important improvements as those combining protection from floods, supplying water for irrigation, perfect drainage, and a network of intercommunications affording the cheapest possible cost of transport.

F. H. RUNDALL, General R.E.

16th March, 1897.

DOES IT PAY TO EXHIBIT?

Mr. BENNETT H. BROUGH writes:—In the case of exhibitions, as in that of advertising, it is a matter of great difficulty to ascertain the exact number of orders that are the direct outcome of the exhibit made. The results of a careful inquiry made at the request of exhibitors by the Bavarian Industrial Museum, the results of which are recorded in *Glaser's Annalen für Gewerbe und Bauwesen*, form a valuable contribution to the knowledge of the subject.

In order to ascertain the commercial advantages derived by exhibiting at the Bavarian Exhibition held last year at Nuremberg, a form was sent to each exhibitor containing four columns—the number of sales, the number of orders, and the value of each. From the replies received, it was found that there had resulted 9,117 sale[illegible] £94,088, and 8,728 ord[illegible]presenting a total value of £75,001. To this must be added the sales in the Fine Arts Section, which amounted to £4,061, so that the total amount derived from the exhibition was £173,150. This sum was divided among the various groups in the following manner:—

	£
1. Mining and metallurgy	1,793
2. Foods	30,851
3. Textiles	8,072
4. Paper	133
5. Leather	6,614
6. Glass	2,102
7. Clay........................	1,742
8. Stone	2,997
9. Metal	21,494
10. Wood	21,632
11. Printing	3,922
12. Scientific instruments	3,133
13. Musical instruments..........	2,126
14. Chemical industry............	2,106
15. Building and engineering......	3,919
16. Transport	2,448
17. Machinery	55,862

	£
18. Horticulture	143
19. Fine arts	4,061

These figures clearly show the great practical value that exhibitions have for commercial purposes.

Obituary.

JOHN BIDDULPH MARTIN, M.A.—The Society of Arts has lost a prominent member by the death of Mr. J. Biddulph Martin, on Saturday, 20th inst., at Las Palmas, Grand Canary. Mr. Martin was a member of Council from 1888 to 1891, and a Vice-President from 1892 to 1894, and he was a frequent attendant at the meetings of the Society. He was one of the members of the Royal Commission for the Chicago Exhibition who visited that Exhibition officially in 1893. He was born in 1841, and educated at Harrow and Exeter College, Oxford. He continued through life to take an interest in athletics, and he was President of the London Athletic Club. He was Foreign Secretary of the Statistical Society for several years, and at his death filled the office of President. Mr. Martin was also a prominent member of the British Association, the Institute of Bankers, the Society for the Promotion of Hellenic Studies, and the Political Economy Club, and contributed papers to most of these institutions. He published the history of the old-established bank in which he was a partner under the title of "The Grasshopper in Lombard Street."

General Notes.

MONACO CONGRESS.—Information has been received from the Foreign Office through the Science and Art Department, that a Congress will be held, this year, at Monaco, by the International Literary and Scientific Association. The Congress will be opened on the 17th April, and will continue for eight days.

GUATEMALA EXHIBITION OF 1897.—As a result of the very large number of applications for space in the above exhibition, which have been received from abroad, the Guatemala Government has decided to erect several supplementary buildings. One of these, 3,000 square metres in extent, will be devoted to the exhibition of machinery, one of 3,000 square metres for French exhibits, one of 3,000 square metres for German exhibits, one of 1,000 square metres for Belgium, and various others for Italy, Chili, &c., and for the fine art section. In consequence, the official opening of the foreign sections will be delayed for about four months, and the time that the exhibition will remain open will be sufficiently prolonged to allow the foreign exhibits to remain on view for a period of four months.

OMAHA INTERNATIONAL EXHIBITION.—An international, industrial, and mining exhibition will be held at Omaha (United States), during the months of June to November, 1898. The promoters of the enterprise had, at first, the intention of limiting the participation in this exhibition to the States of the Union situated to the west of the Mississipi, but according to a recent decision it is now to be open to the exhibitors of all countries. A Belgian publication, calling attention to this fact, urges upon the commercial community in that country not to lose the opportunity of taking part in this exhibition, and calls attention to the importance of making their manufactures known in the Trans-Mississipi States, the total area of which exceeds the half of that of the whole North American continent. Goods intended for exhibition will enter free of duty; and each exhibitor will have the right to a free announcment of twenty words in the official catalogue.

JAPANESE BAMBOO.—Bamboo and bamboo wares constitute an important item in the miscellaneous export commerce of Japan. Bamboo for shipment abroad is grown in districts adjoining Kyoto and Osaka, and in Shikoku, and in Kyushiu, the varieties differing somewhat, according to localities. In Hiroshima the black and the spotted varieties grow, the former is produced in Kochi, also in many parts of Kyushiu. Bamboo grown in Yamaguchi, Oita, and Ehime belongs to the cheap varieties. The cultivation of black bamboo is carried on extensively in Kochi where a *tan* (a quarter of an acre) of bamboo yields 30 to 60 *yen* per year. Bamboo is exported to most countries of Europe and also to America and Australia. The bulk of the bamboo shipped from Kobe—from which place nine-tenths of the total are exported—goes to England, the varieties being black, spotted, and white. To France and Germany the black and white sorts of the best quality are shipped, while long, bleached angling bamboos are in demand in New York.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

MARCH 31.—"Cycling—Historical and Practical." By GEORGE LACY HILLIER.

APRIL 7.—"Dairy Produce and Milk Supply." By M. J. DUNSTAN, M.A., F.R.S.E. The RIGHT HON. LORD BELPER will preside.

Papers for meetings after Easter.

"London Water Supply." By PERCY F. FRANKLAND, Ph.D., F.R.S.

"Silver and Prices: the Economic drain of Debtor Nations." By MORETON FREWEN, B.A.

"Children's Sight." By R. BRUDENELL CARTER, F.R.C.S.

"Fireproof Construction." By THOMAS POTTER.

"Motor Traffic: Technical Considerations." By Sir DAVID SALOMONS, Bart.

INDIAN SECTION.

APRIL 1, at 4.30 p.m.—"A Visit to Russian Central Asia." By MICHAEL FRANCIS O'DWYER, I.C.S. (Assistant Commissioner in the Punjab).

MAY 6, at 4.30 p.m. — "Kafiristan: its Manners and Customs." By SIR GEORGE SCOTT ROBERTSON, K.C.S.I. (late British Agent at Chitral). FIELD-MARSHAL LORD ROBERTS, V.C., G.C.B., G.C.S.I., G.C.I.E., will preside.

MAY 20, at 4.30 p.m.—"India and its Commerce." By SIR JAMES LYLE MACKAY, K.C.I.E. (late President of the Bengal Chamber of Commerce).

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

APRIL 6.—"Recent Travels in Rhodesia and British Bechuanaland." By C. E. FRIPP. AUGUSTUS HELDER, M.P., will preside.

MAY 4.—"The Arctic and Antartic." By AUBYN TREVOR-BATTYE.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock:—

MARCH 30.—"Lead-work." By W. R. LETHABY. Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., will preside.

APRIL 27.—"Delft Ware." By Dr. J. W. L. GLAISHER, F.R.S.

MAY 11.—"A Half Century of Line Engraving, 1780-1830." By GEORGE CLULOW.

CANTOR LECTURES.

Monday Evenings, at half-past 4 o'clock:—

PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., "Alloys." Four Lectures.

LECTURE III.—MARCH 29.—Steel and cast-iron, considered as carbon—Iron alloys.

LECTURE IV. — APRIL 5. — Advances in our knowledge of alloys since the last course of Cantor Lectures "on Alloys" was delivered, in 1893.

LEWIS FOREMAN DAY, "Design in Lettering." Four Lectures.

May 3, 10, 17, 24.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Cantor Lectures.) Prof. W. Chandler Roberts-Austen, "Alloys." (Lecture III.)

British Architects, 9, Conduit-street, W., 8 p.m. Mr. J. A. Gotch, "Heraldry of the Renaissance in England."

Actuaries, Staples-inn-hall, Holborn, E.C., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Henry Speyer, (i.) "Snowdon in Winter;" (ii.) "Climbing in Dauphiné."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. J. Priestley, "Ventilation, Warming, and Lighting."

TUESDAY, MARCH 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. W. R. Lethaby, "Lead-Work."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. D. Waller, "Animal Electricity." (Lecture XI.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Self-Propelled Traffic Association, Colquitt-street, Liverpool, 8 p.m. Paper on "Serpollet's System."

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Drs. B. C. A. Windle and F. G. Parsons, "The Myology of the Terrestrial Carnivora." 2. Mr. C. S. Tomes, "Note upon the Minute Structure of the Teeth of *Notoryctes*." 3. Mr. R. Lydekker, "On the Blue Bear of Tibet, with Notes on the Members of the *Ursus arctus* Group." 4. Mr. G. A. Boulenger, "An Account of the Freshwater Fishes collected in Celebes by Drs. P. and F. Sarasin."

WEDNESDAY, MARCH 31...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. George Lacy Hillier, "Cycling: Historical and Practical."

Chemical, Burlington-house, W., 3 p.m. Annual General Meeting.

United Service Institution, Whitehall, S.W., 3 p.m. Major-General A. B. Tulloch, "The Education and Training of Naval and Military Cadets."

British Astronomical, University College, Gower-street, W.C., 5 p.m.

THURSDAY, APRIL 1...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Michael Francis O'Dwyer, "A Visit to Russian Central Asia."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. A. J. Ewart, "The Evolution of Oxygen from Coloured Bacteria." 2. Miss Helen Beatrix Potter, "The Germination of Spores of Agaricineæ."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. E. Aston and Dr. G. Norman Collie, "The Oxidation of a. y dimethyl a'-chloropyridine." 2. Mr. K. J. Williams, "The Composition of Cooked Fish."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. Boyd Dawkins, "The Relation of Geology to History." (Lecture II.—"The Frontier of History in Britain.")

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. J. W. Peggs, "Principles of Calculating Areas—Interpretations of Plans, &c., to Scale."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. T. C. Porter, "Mountain and West Coast Scenery at Home and Abroad."

FRIDAY, APRIL 2...Royal Institution, Albemarle-street, W. 8 p.m. Weekly Meeting. 9 p.m. Mr. C. T. Heycock, "Metallic Alloys, and the Theory of Solution."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, APRIL 3...Royal Institution, Albemarle-street. W., 3 p.m. Lord Rayleigh, "Electricity and Electrical Vibrations." (Lecture V.)

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FRIDAY, APRIL 2, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Professor W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., delivered the third lecture of his course on "Alloys" on Monday afternoon, 29th inst.

The lectures will be printed in the *Journal* during the summer recess.

APPLIED ART SECTION.

Tuesday, March 30th; Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., in the chair.

The paper read was on "Artistic Leadwork," by W. R. Lethaby.

The paper and report of the discussion will be published in the next number of the *Journal*.

JOURNAL ADVERTISEMENTS.

From the present date all arrangements connected with the advertisements in the Society of Arts *Journal* will be in the hands of Messrs. Street Brothers, of 5, Serle-street, Lincoln's-inn, W.C. All communications, therefore, referring to advertisements should be addressed in future to Messrs. Street.

SHAW PRIZE COMPETITION.

The Council of the Society have awarded the prize for Industrial Hygiene, offered under the terms of the Benjamin Shaw Trust, viz., a gold medal or £20, to Messrs. Oakes and Leigh, of Willow-street, Burnley, for their improved shuttle guard.

The judges, to whom the matter had been referred by the Council, reported that their guard appeared to provide, at a moderate cost, an important security which might previously have been obtained at a practically prohibitive price by means of former inventions.

The prize was offered under the conditions laid down by the testator:—"For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means."

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The fourth meeting of the Congrès International de l'Enseignement Technique will be held this year in London, commencing on the 15th of June next. The previous meetings of the Congress were—in 1886 at Bordeaux, in 1889 at Paris, and in 1895 at Bordeaux. The meeting will be held at the invitation of the Society of Arts, and of the Worshipful Companies of Drapers, Fishmongers, Goldsmiths, Merchant Taylors, and Clothworkers.

The Congress will be opened at 11 o'clock, on the 15th of June, by an address from the President, the Duke of Devonshire, K.G., and from the President of the last Congress, M. le President Léo Saignat. The meetings will be held on Tuesday, Wednesday, Thursday, and Friday, from 11 to 1, and from 3 to 5.

The subscription to the Congress, for others than delegates of Foreign Governments, members of the Society of Arts, or liverymen of the companies subscribing, will be 5s. This will entitle them to a copy of the Report of the Proceedings.

Applications from persons desiring to become members of the Congress can be received at any date, and should be accompanied by the amount of the subscription. In return a ticket will be sent entitling the member to all the privileges of the Congress.

Members of the Society of Arts and liverymen of the companies will be admitted to the meetings of the Congress on signing their names at the door.

The subjects for discussion at the Congress will include:—

Technical Education:—

1. Advanced Instruction. Polytechnics, Universities, Colleges.

2. Secondary Instruction. Higher Technical Schools; Secondary and Intermediate Schools; Evening Schools.

Commercial Education:—

1. Advanced Instruction. Colleges; High Schools and Institute of Commerce.
2. Secondary Instruction. Commercial Schools; High Schools; Classes for Adults.

It is not proposed to deal with elementary Technical or Commercial Education. The education of both sexes will be included. Further information will be issued at a later date.

The Executive Committee will be glad to receive offers of papers coming within the scope of the subject as above defined. The papers must be in the hands of the Secretary not later than the 29th May.

The meetings will be held in the great room of the Society of Arts. Should it be found desirable to arrange for sectional meetings, accommodation will be provided in the neighbourhood.

The papers will be printed and distributed at the meetings. The reader of each paper will be allowed a quarter of an hour to state the substance of the paper.

The proceedings of the Congress will be reported in English. Papers intended for the Congress, may be in French, German, or English, and speakers may make use of any of these languages.

All communications relating to the business of the Congress should be addressed to the Secretary, Society of Arts, John-street, Adelphi, London, W.C.

The Rt. Hon. the Lord Mayor of London has kindly invited members of the Congress to an evening reception at the Mansion-house on the 17th June. The Society of Arts annual Conversazione will be held on Wednesday, the 16th of June, and members of the Congress will receive an invitation to it. On Saturday, the 19th of June, it is proposed to organise an excursion, for foreign delegates, to some place in the neighbourhood of London.

The Committee cannot undertake any arrangements with regard to hotel accommodation, lodgings, boarding-houses (*pensions*), &c., nor can they correspond with members of the Congress on the subject; but they have arranged with Messrs. Thomas Cook and Son, Ludgate-circus, London, E.C., who have undertaken to provide accommodation for visitors who will let them know in good time.

Prices at hotels and lodgings in London may be on a higher scale than usual, owing to the celebration of Her Majesty's Jubilee, which takes place in the week after the Congress meeting, and for the same reason accommodation may be more difficult to obtain than is usually the case. It is therefore desirable that members of the Congress requiring accommodation should apply to Messrs. Cook as early as possible, giving them the fullest information as to the kind of accommodation they are likely to require, the numbers of their party, the time of their arrival, the duration of their stay, &c.

HENRY TRUEMAN WOOD,
Secretary.

Proceedings of the Society.

INDIAN SECTION.

Thursday, March 25, 1897; Sir WILLIAM HENRY HOULDSWORTH, Bart., M.P., in the chair.

The CHAIRMAN said it gave him great pleasure to preside on this occasion, because, although he had heard something on the subject of Rhea fibre, he was very anxious to learn more. To a manufacturing country, snch as England, any new raw material was of importance, and no suggestion of any such material, on which industry could work, should be lightly treated. Every opportunity should be afforded to see what could be made of it. It appeared to him, that there were three conditions with which any new textile material must comply, if it were to be of real service. In the first place, there must be a fairly plentiful and constant supply available; secondly, it must be capable of manipulation, so as to bring it into the form of yarn or thread, in order that it might be operated on to the weaver; and though one recognised that in the case of a new material, special machinery might require to be invented, and made to suit it, still, it must be made evident from the first, that there was no absolute impossibility to its being dealt with in some way or other by machinery; lastly, the cost must not be excessive, compared with that of materials already in use, for which it was suggested as a substitute. Of course, this last condition must not be pressed too far, because, if any new material were discovered, which had special properties of its own, special beauty, or special strength, the cost, even if higher, might not be a bar to its use, would not be so important, and might well be overlooked.

The paper read was:—

THE CULTIVATION AND MANUFACTURE OF RHEA FIBRE.

By Thomas Barraclough.

The subject of rhea, or ramie, is much too extensive for a full treatment of it to be compressed within the time allotted for a paper. I have, therefore, carefully considered how, whilst doing justice to the subject generally, I can bring my paper within the usual time limit.

I propose to refer very shortly to the leading qualities of the fibre; to point out various matters in which the general knowledge concerning the cultivation of the stems has been increased and more clearly defined; to set forth the causes of the comparative non-success of the fibre up to the present; to describe the present position both of the decortication and manufacture of the fibre; and I shall close with a few remarks as to its future prospects.

In giving details and figures in relation to production, cost, manufacture, price, &c., I think it advisable to make an important reservation.

The growth, production, and quality of ramie vary very much, according to climate, soil, mode of cultivation, and treatment of the fibre. There are, therefore, many elements of uncertainty, such, for instance, as the cost and the weight of the crop grown per acre, the number of crops that can be obtained annually, and the percentage of fibre contained in the stems. My figures must be taken as representing a general average, liable to modifications according to circumstances.

In relation to the preparing and spinning of the fibre, the same reservations should be made, because the fibre being of various qualities and lengths, and spun into yarns, which vary in size from 1,000 to 40,000 yards per pound, the statistics given should be accepted as liable to modification according to circumstances.

Ramie, called in India "rhea," and when grown and prepared in China, known as "China grass," belongs to the family of nettles, *(Urtica)*, and to the sub-division *Boehmeria*. There are many varieties of the plant, but the two which have been proved to be the best fibre-bearing species are *B. Tenacissima*, often called the green-leaved ramie, and *B. Nivea*, often called the white-leaved ramie, on account of the silvery appearance of the underside of its leaves. The *Nivea* species is mostly cultivated in China and Formosa, and the *Tenacissima* in Java, Sumatra, Borneo, Malacca, India, Mexico, and other tropical countries.

Many attempts have been made to successfully cultivate ramie in temperate zones, and at one time great expectations were raised as to the possibility of successfully growing the fibre in France, Holland, and countries enjoying a similar climate, but these expectations have not been realised, as the plants are not able to resist winter cold, unless protected to such a degree and at such an expense as to cause their cultivation to be too costly. At one time it was expected that the cultivation of rhea in India would prove of immense benefit, but careful study and experience have shown that something more than a merely tropical climate is required.

Warm moisture is the first requisite to the soil for cultivation, but anything approaching stagnation of water on the land, even for a short period, is the ruin of an estate. Plenty of water always in the soil and yet ready absorption of all that falls are true essentials in ramie land. This implies friability of surface soil to soak in the moisture and porosity of the subsoil to absorb the excess of water or heavy rains. The land must be sufficiently elevated to run no risk from floods.

Moisture and warmth in the land depend largely upon moisture and warmth in the atmosphere. Therefore, a plentiful rainfall is indispensable, coupled with a high and even temperature. The rainfall must not only be plentiful but it must be well distributed throughout the year. The greatest enemy of ramie after stagnant water is drought. Dry heat burns it up; drought kills it outright. What ramie requires is a naturally rich soil, plenty of rain, and no extremes of temperature.

It was at one time generally supposed that the whole of India is suitable for growing rhea. Such, however, is not the case. Districts in India, the climate and soil of which are in accordance with the above requirements, can produce any quantity of rhea, and if the authorities will foster and protect the cultivation, India will doubtless become one of the most important producers of rhea fibre.

It is a perennial, giving from two to five crops annually, and when well established on the land, yields its crops for a succession of years. The roots become stronger and stronger each year as they spread through the soil, and the plant becomes more and more productive. It yields a crop the first year if grown from seed. If planted from root cuttings it can give two crops in the first year. Owing to the quantity of tannin in the bark it is singularly free from insect pests and fungoid diseases. An estate of 500 acres of ramie under good cultivation and favourable circumstances produces yearly from 7,000 to 9,000 tons of green stems, calculating four crops per year; of which about 5 per cent. is fibre.

The leading qualities of ramie fibre may be summarised thus :—

It is the strongest fibre known.

The comparative tensile strength of some of the leading fibres may be taken as follows :—Assuming the strength of ramie to be 100, the strength of hemp is 36; flax, 25; silk, 13; and cotton, 12.

It is the longest of all textile fibres. Its filaments range in length from 2½ in. up to 12 in. The filaments of flax vary in length from ⅙ in. to 2½ in.

Ramie fibre has a brilliancy or lustre superior to that of all other textile fibres. In this respect it may be compared with silk, which it almost equals. In certain classes of goods only an expert can distinguish between silk and ramie. When properly gummed, prepared, spun and woven, this lustre is not affected by the processes, but shines forth as brightly in the woven piece as in the fibre. Ramie resists atmospheric influences better than any other fibre. Air and water have little influence on it, however long a time exposed. This has been amply proved in the case of fishing nets made of ramie, which have lasted far beyond any other material that has ever been used for the purpose. It mixes easily and freely with silk, wool, cotton and flax, and the combinations thus obtained are very valuable in point of colour, durability, and economy. It takes colours freely in dyeing, and the very best effects of colour are obtained without affecting the lustre.

One of the difficulties that has impeded the spread of the cultivation of ramie has been the planting. It has been assumed for many years that the best way to propagate ramie was by means of stem or root cuttings. In order to obtain these cuttings, plants have been procured with great difficulty and risk, and at great expense. Many people have been discouraged by the difficulties and the expense, and in many cases it has not been possible to obtain plants. Sowing has been tried in a few cases, but has resulted mostly in failure, hence the idea that ramie is best propagated by cuttings.

From a friend of large experience in the East, Mr. Matthieu, of Singapore, I have quite recently obtained special information, which points to the fact that propagation by sowing has been rejected through ignorance of the proper method of sowing. I cannot do better than make known the result of his practical knowledge and experience.

"It is commonly said that an ounce of practice is worth pounds of theory, and it may not be amiss to give here the results of my own experience in ramie propagation by seed. It requires great care, but if the seed be good, the results obtained are an ample reward for the trouble taken. My first attempt ended in failure. One month later I sowed some seed on a bed made of fine sifted earth with a slight admixture of well-rotted cow-dung; the bed was well sheltered by a lallang roofing, and, in fine, every precaution was taken to insure success. The result was far from satisfactory; little patches of green here and there showed that germination had partially taken place, but the sowing was practically a failure. I then referred to the precepts given by 'The Imperial Treatise of Chinese Agriculture' on the subject of the rearing of the plant. This work says :—

"'For the purpose of sowing a light sandy soil is preferred. The seeds are sown in a garden near a river or well. The ground is dug once or twice, then beds are made, and after that the earth is again dug. The ground is then pressed down with the back of a spade. When it is a little firm it is slightly raked, the beds are watered, and again loosened with a fine rake, and finally levelled. After that a ching (a measure) of moist earth and a ho (a measure) of seeds are taken and well mixed together. After having sown the seed it should not be covered with earth; indeed, earth on the top prevents germination. Cover with a slanting roof of matting. Before the seed begins to germinate, or when the young leaves first appear, the beds must not be watered. By means of a broom dipped in water the roof of matting is wetted so as to keep the ground underneath moist. When the plants are about two inches high the roof may be laid aside. If the earth is dry it must be slightly moistened to a depth of about three inches. A stiffer soil is now chosen and formed into beds to which the young plants are to be transferred.'

"I followed the Chinese method in all its minuteness, with the most gratifying results. I have, therefore, no hesitation in stating that of the three modes of propagation open to the ramie planter, seed, stem or root cuttings, the first appears to me to be the most practical, the cheapest, and probably the quickest in the case of a large estate."

Although one cannot go far wrong in adhering closely to the Chinese text, I think, for the sake of conciseness, the following may be substituted for it. Germinate the ramie seed in open boxes in a roofed house. Fill the boxes with earth; for top soil take a light loam, pulverise it thoroughly by passing it through a ¼-in. sieve: a slight admixture of burnt earth or dung will keep it moist without it being necessary to water it for some days. Mix a small quantity of the seed with one basketful of the prepared soil. Sprinkle this so l over the earth in the boxes. Do not water until after five or six days (sometimes ten days) when the seminal leaves begin to appear. When watering use a very fine rose. When the young seedlings are 2 in. to 2½ in. high, transfer them to the nursery in specially-prepared beds, planting them 3 in. apart. If taken out with a ball of earth round their roots they bear transplanting well, and from that time need only the usual amount of attention and care which all young plants require—shading, watering and weeding.

Propagation by stem or root cuttings is generally assumed to be the most expeditious, producing a crop more quickly than by sowing. It may be so in the case of a small acreage, say 500 acres.

If 10,000 cuttings are procured for purposes of propagation, one may, after six months (it is not advisable to do so before) obtain a supply of root and stem cuttings, say twenty from each original stool, which will bring the number of cuttings up to 200,000, capable of planting sixteen acres. After further six months, 4,000,000 cuttings may be obtained, capable of stocking, under favourable circumstances, about 315 acres. It will be fully eighteen months before the full acreage of 500 acres will be supplied. During that time there will have been but few, if any, stems available for crop, as they will have been cut up for purposes of propagation.

It is well known that propagation by cuttings is apt to bring degeneration, and it is necessary from time to time to revert to seed to obtain a healthy stock of plants; plants grown from seed possess the tap root, and are not so liable to spread their roots laterally to an undue degree. This is shown by the practice followed by the Chinese themselves in the cultivation of ramie, who reserve some of the best stems for seeding purposes. Notwithstanding the widespread opinion to the contrary, it appears that planting from seed is the right method, and that every effort should be made to follow it. In the few cases where good seed is not procurable, but only cuttings, it will undoubtedly be advantageous to reserve some of the best plants thus raised exclusively for seeding.

When propagating from seed, a small crop of fibre may be available for sale the first year, the planting will be more systematic, and the growth of the stems more uniform, a great desideratum in view of obtaining fibre of one standard and one quality. The work of uprooting the stock plants grown from cuttings is a laborious one, which is dispensed with in the case of propagation by seed.

Plantations raised from seed are longer lived than those raised from cuttings. The Ram Ragh Estate, planted in 1878, is still giving crop notwithstanding the abandonment of cultivation consequent on the death of its owner in 1880, seventeen years ago. Of this I have most precise and conclusive evidence recently given me by the present occupier of the estate.

Mr. C. Riviere, Director of Hamma Garden at Algiers, says:—"Our trial to raise ramie from seed proved successful; 250,000 fine plants were obtained, remarkable mostly by their vigour, the size of the foliage, the height of the stems, and the fine development of their roots."

Experience has shown that former ideas respecting the space required for plants need modification. These were planted too far apart, and as a consequence the stems freely threw out branches. Each branch breaks the continuity of the fibres, and causes a larger proportion of short fibres. Too much space between the plants also favours the growth of weeds.

What have been the causes of the failure of this fibre to take its proper place in the market? The failures may be attributed largely to ignorance. Many enterprising men have put forth great endeavours to grow this fibre, and to bring it into practical use, and their experience has added materially to the general knowledge; but the growth of practical knowledge has been slow and the resulting failures many. One of the principal causes of this has been that each man in his department has been working with limited ideas, and ignoring that there must be a combined working together in order to ensure success.

The planter has in many cases planted ramie without understanding its nature and requirements. The climate and the soil have been unsuitable, the treatment of the plants mistaken, the means of turning the proceeds of the crop into a marketable article have been wanting, hence failure and disaster.

The so-called decorticating machines have contributed largely to the many failures. Their name has been a misnomer. Instead of decorticating, that is, removing the skin, they have simply removed the internal pith or wood, and produced what are called in the trade "ribbons." These, when sent to the market by the grower, have proved to be, practically, unsaleable. The consequence has been disappointment, in almost all cases, where ramie has been grown. The grower did not find a market for his products, and, therefore, his scheme for large plantations gradually died out.

On the other hand, the manufacturer, not seeing his way to obtain regular supplies of ramie in a form in which it was practical for him to deal with, has been compelled to ignore it. Early experiments in the preparing and spinning of the fibre soon proved that it could not be satisfactorily treated by existing textile machinery, and that special machines must be constructed. No manufacturer will invest his capital in new machinery, of special construction, unless he is first assured of a plentiful supply of the raw material in practical form.

In like manner, a large proportion of the degumming processes, of which such a large number (about 100) have been patented, have been defective because they have injuriously affected the strength of the fibre, or its brilliant lustre. They have made it harsh and brittle, and have rendered it difficult to dye. In many cases, the fibre has been felted and matted to such a degree, that at the combing-machine the short fibre or noil has amounted to 50 per cent. or 60 per cent. instead of 20 per cent. to 30 per cent.

Considerable quantities of goods produced from ramie have become quite rotten and even gone to powder, a few months after weaving, the result of employing in the degumming and bleaching processes unsuitable chemicals, injurious to the fibre.

It will thus be seen that each process must be carried on with due regard to subsequent processes, for instance, the decortication must take place in such a thorough manner, that the subsequent process of degumming is rendered easy and economical. The machine must on no account bruise the fibre, as bruised and broken fibres mean great loss in the combing operation.

In like manner the degumming and bleaching operations must have regard to the subsequent combing and spinning, and to the dyeing operation, and to the general condition of the goods after they are manufactured.

For many years there existed a strong opinion—especially in France—that the most practical way to treat ramie stems was to dry them, and afterwards to decorticate them. The idea was good so far as it went, because, as in the case of flax and hemp, there are many advantages to be gained by cutting the crop, letting it dry, storing it, and extracting the fibre later on, when the labour of the farm is not otherwise occupied. It allows also of the possibility of sending the dried stems in quantities to central works to be treated on a large and economical scale.

In tropical countries the drying process was a failure because the stems fermented instead of drying in the humid climate, and artificial drying was too expensive to be adopted.

This opinion undoubtedly retarded seriously the manufacture of ramie for many years, because it was based on two serious mistakes that have needed years to expose and overcome.

Each stem of ramie is surrounded with a skin or pellicle. This skin, if allowed to dry on the stem, assumes a brown colour, clings to the fibre with remarkable tenacity, and has been the cause of the major portion of the degumming patents that have been taken.

The chemists only partially succeeded in their treatment, because in removing the brown skin they too often attacked the strength of the fibre, destroyed its lustre, made it harsh and brittle, affected its character for receiving dyes, and matted it, causing great loss in combing.

Another and very serious matter which has militated against the success of ramie has been the introduction of schemes for growing and treating ramie in which the company promoter has played the leading part, and in which the man of practical knowledge has been conspicuous by his absence. Many of these schemes have resulted in failure and disaster, large sums have been lost by investors, and, unfortunately, ramie has too often been blamed instead of the speculator, so that in some circles the very name of ramie is offensive to the ear, bringing up unpleasant memories of past losses. In all these cases the blame is due, not to the fibre, but to the ignorant enthusiasm of everybody concerned, in some cases, and to the cupidity of the company promoter in others.

The problem, commercially considered, has been to obtain a machine which can carry out economically the following processes without damaging the fibre: (*a*) Remove all the woody parts from the green stems; (*b*) remove the outer skin or cuticle which has so long baffled all mechanical efforts to remove it; and (*c*) extract as much as possible of the juice of the stems so as to simplify and cheapen the degumming process.

The two former processes are effectively carried out by hand-labour in China, where women and children scrape every stem and remove the skin and the wood, but leave most of the juice in the fibre.

All inventors of ramie decorticators have concentrated their efforts on machines to produce ribbons. Needless to say the object aimed at fell far short of the real necessities of the case, hence some of the long delays and numerous disappointments with which this fibre is associated.

Ramie ribbons or strips must always be considered unsatisfactory, and will, no doubt, in time disappear. The buyer has no means of readily testing their value, the quality and percentage of the fibre, and whether damaged or not by the decorticating machine; hence his objection to an unknown article, in addition to which they cannot be highly compressed and packed into proper bales as other fibres are, because the large quantity of pieces of wood in them cut the fibre. They also contain a very large percentage of useless material on which freight has to be paid.

It has been reserved for a Frenchman, Mr. Faure, to construct a machine capable of producing not ribbons, but the fibre in one operation, free from woody matter, from skin, and with the least possible amount of juice in it. The product is equivalent to China grass.

A skilled engineer and machine maker, with every facility at his own works, and ample means for carrying out his ideas, he had the benefit of another important advantage, viz., the growing of ramie on his own estate in the Limousin near his works, which enabled him to practically test his ideas by actual experiments on the raw material—a combination of advantages probably not enjoyed by any other inventor of decorticators. Patiently and scientifically he has, step by step, worked out the problem, and the machine represents the result of his several years labour. It is simple, inexpensive, and does its work admirably.

It is fed by the insertion of lots of about ten stems. The stems are used in the same condition as cut, with the leaves on. The operation of feeding is as follows:—The stems are passed in twice. They enter the machine butt ends first, and after having been treated about six inches of their length, they are withdrawn, an operation easily carried out, and fed in a second time, the leaf ends first, so as to complete the operation. It frees the stems from all woody matter and from the outer skin or cuticle, and extracts a large portion of the juice, thus producing fibre retaining all its valuable qualities.

The machine, which weighs 11 cwt., is very strong and not liable to get out of order. It consists mainly of the framework and driving gear, the decorticating drum carrying beaters and the feed bed. This latter is the important feature of the machine, by reason of its special contour, which varies at different parts, to suit the various descriptions of work which the machine has to perform. The first part of the bed is curved outwards, the second is straight, and the third is curved inwards. The ramie stems are fed into the machine over the first part of the bed, where the woody portion becomes immediately broken and partly removed; the strip passes on to the second part, and as the speed of the beaters is considerably greater than that at which the stems are fed into the machine, a scraping effect is produced on the strips, seeing that the distance between the beaters and the surface of the bed is less than the thickness of the strip. This scraping action effects a double purpose: it attacks the outer skin, and also all matters extraneous to the fibre. The strips or sticks of filaments then pass down vertically into the machine, and the separated matters, viz., most of the woody parts, the skin, and gummy substances, are thrown out to a distance by the centrifugal force of the beater drum. When the stems have entered to within a short distance of their end, the return movement is effected, and they are withdrawn. During the withdrawal the following action takes place:—At the inward curve, or third part of the bed, the filaments are slightly and gradually grazed by the beater blades, which throw out the coarser of the *débris* still adhering. The operation is performed with great delicacy; the fibres assume the position of the chord of the curve, and are constantly agitated by the beaters. When the fibres arrive at the second part of the bed, as the space between it and the beaters is infinitely reduced, the entire removal of matters still adhering to the fibres is effected, and these latter leave the machine white, parallel, and free from woody matter, from skin, and from the major portion of the juice. The concave bed or breast is mounted in such a way that its position to the action of the beaters is easily regulated. The brackets which carry the bed are supported by spiral spring cushions and flexible legs, the object being to obtain a rubbing action between the beaters and the fibre, having for its special object the loosening and removal of the skin or outer cuticle. The elastic bed gives way or vibrates an enormous number of times per minute, and this produces the desired rubbing, or "knuckle-joint" action between the beaters and the fibres on the bed. The shape of the feed-bed causes it to remain clean and free from extraneous matter through the action of the beaters. Choking is thus rendered impossible. All abnormal strains are avoided, and the machine can be kept at work from morning till night without stoppages for cleaning. The refuse falls underneath the machine, and is removed from time to time. In the case of a number of machines working together, an endless band or conveyer, passing under the machines, removes the refuse continually, and so keeps the neighbourhood of the machines perfectly free from it.

The machine is capable of being easily worked by native labour in the ramie plantations, or in works connected therewith. Although simple, it needs to be constructed with the greatest accuracy in order to ensure effective working. The cylinder, carrying the steel beaters, is perfectly balanced and accurate in its action; it runs at 520 revolutions per minute; the surface of the beaters is perfectly parallel with the setting of the feed-bed, and capable of working close up to it, say within a distance equal to the thickness of a piece of writing paper. The feed-bed, the varying profile of which is of such enormous importance in the efficacy of the machine, is made with the greatest of accuracy by special machinery.

With regard to the production, practical experience shows that one machine, worked by two men, can treat 360 lbs. of fresh green stems per hour, or about 32 cwts. per day of ten hours. The amount of dry fibre produced depends largely on the nature of the stems; the percentage of fibre contained in green stems varies very much according to circumstances. On a 5 per cent. basis, the nett production of dry fibre of each machine per day of ten hours is 180 lbs. When the stems are specially good, 200 lbs. of dry fibre have been produced per machine in ten hours. Under ordinary circumstances, a production varying from 160 to 200 lbs. of dry fibre in ten hours per machine may be expected.

Each machine requires about one indicated h.-p. to drive it. When a number of machines are working together less power will suffice; thus, 8 h.-p. will drive ten machines.

The machines produce a fibre which ranks in the market with China grass, by reason of its regularity in condition and quality. The buyer can easily see and test what he is buying. He is, therefore, able to give it its proper classification and pay its full market value; in addition to which, by reason of the bales being well pressed and containing little else than ramie fibre, the freight and expenses per ton are reduced to a minimum.

Green stems grown in a tropical or subtropical climate give the best results. The growth being quick, the stems carry plenty of fresh green juice, which assists the decortication very much by leaving the fibre freely and carrying with it in its downward course from the beating point of the machine large quantities of extraneous matter. The condition of the stems at the time of treatment also plays an important part. In order to ensure the best possible fibre, the stems should be treated within a few hours of being cut. They should not be over-ripe, as the fibre deteriorates after the stems have arrived at maturity. The best plan is to cut them either just at full maturity or slightly before. The fibre thus obtained excels in whiteness and ductility, retains its full lustre, and shows to the best advantage during subsequent manufacturing operations, such as preparing, combing, spinning, dyeing, &c.

The machine has worked during the seasons of 1895 and 1896 near Limoges in the presence of experts and fibre growers. In each season it has treated two crops, and the fibre obtained has proved, after degumming and combing, to be equal to the best China grass.

It is claimed for this machine that it has solved the question which has heretofore been one of the chief difficulties in connection with ramie.

The grower can now produce ramie fibre from his stems in such a condition that it needs only drying, packing, and sending to market in order to turn it into money, and as the margin of profit is large, there can be no doubt that the cultivation of ramie will henceforth increase each season.

The position of the manufacturer is entirely changed. His raw material will come into the market in regular quantities in a condition in which he can easily utilise it, so as to enable him to be sure of an ample supply.

The cost of extracting the fibre from the green stems, drying and packing it into bales, amounts to about 3s. 9d. per ton of stems treated, or £3 15s. per ton of dry fibre obtained—when working with ten machines and native labour at 1s. per day—including motive power, stores, &c. If the labour is calculated at 2s. per day, the cost will be 5s. 1½d. per ton of green stems, or £5 2s. 6d. per ton of dry fibre obtained, assuming that the stems give 5 per cent. of fibre.

The cost of extraction is, of course, liable to be much effected by the price of labour, the cost of motive power, and by various local circumstances.

The processes of degumming have undergone immense improvements in the last few years. These improvements have been in the direction of simplifying the apparatus used, and of employing chemicals in the weakest form possible by the use to the fullest extent of high pressure steam in closed vessels in which the material is treated. The fibre is not injuriously affected in any of its qualities by great heat.

There has never been any serious difficulty in the degumming of China grass, because it is free from wood and skin, and, therefore, only the gum has to be dealt with; but the degumming of ribbons has presented many serious difficulties by reason of the skin, the wood, and the gum having to be removed. Hence the large number of patentees and processes.

Manufacturers use a variety of processes and apparatus. As a rule, the most successful of them keep their processes of degumming and bleaching to themselves, and do not patent them.

I do not think it desirable to enter here into any details of the various degumming processes or to criticise them. Many of them are the subject-matter of patents. Opinions differ so immensely as to the efficacy of some of the processes and the value of some of the patents, that discretion on my part will be the better part of valour, and I pass them by without criticism. I limit myself to saying that, generally speaking, the use of closed vessels capable of supporting very high pressure, a plentiful application of steam and water, the employment of the smallest possible amount of chemicals, characterise the best and simplest degumming processes of to-day, and you will see some of the results in the collection of samples before you.

The bleaching process has also undergone very important modifications. The chemist has been led to carefully study his chemicals in view of the fact that not only must the bleached fibre retain its full strength, lustre, and ductility, but also its capacity for being easily dyed, and whether dyed or undyed, the goods manufactured from the bleached fibre must not deteriorate in any respect by age.

Experience and careful study have enabled manufacturers so to modify and simplify both their bleaching and dyeing processes as to retain in the fibres, so treated, all their good qualities.

At present the process as generally carried out on the Continent costs approximately as follows:—£3 per ton of raw material for simple degumming; £4 15s. per ton of raw material for degumming and preparing for spinning; £8 per ton of raw material for degumming, bleaching, and preparing for spinning.

The cost of this latter process in England is variously estimated. The most successful manufacturer of ramie informs me that his process for degumming, bleaching, and preparing for spinning costs him about £11 per ton, calculated not on the raw material, but on the weight of the material after treatment. These costs include materials, labour, and all charges incidental to the process.

I am exceedingly indebted to Mr. Baumgartner, of Emmendingen, Germany, managing director of the largest ramie spinning-mill there is, for a collection of samples which you will have the opportunity of inspecting at the close of the meeting. You will find the raw material a collection of various kinds of yarns, and a considerable variety of goods, woven and knitted, principally of ramie. In some of them you will observe a mixture of wool. You will also see a collection of ramie yarns dyed in many colours.

Amongst the samples I would draw special attention to the plushes—plain and figured—for curtains, tablecloths, and general upholstery purposes, a branch of business in which the Germans excel.

I am, also, much indebted to Messrs. James Finlay and Co., of London and Derby, for the loan of a very large and complete collection of their manufactures, and my friend Mr. Longmore, formerly their managing director, is himself personally present to show and explain these samples.

You will find samples of a very large variety of goods. Many of them imitate silk. Many of them are mixed with silk; there is also a great variety of fancy dress goods, yarns of all kinds and colours, sewing thread and crochet thread, all of the very highest quality.

You will observe in all the samples of goods shown that the natural lustre of the fibre has been preserved to a degree of perfection which is unsurpassable. In fact I may, in justice, describe the collection of samples as one that shows thoroughly the fullest extent to which ramie can be utilised in the manufacture of goods.

Before referring to the spinning and weaving processes, it may be advisable to give a list of the goods produced from ramie yarn. I have, therefore, divided them into four categories, according to quality, cost of production, &c.

A. The finest classes of goods, such as silk mixtures, imitation silks, and light fancy dress goods of various kinds. Laces and lace curtains.

B. Plushes, plain and fancy, for upholstery, Damask curtains, smallwares, upholstery trimmings, heavy mixed goods, hosiery.

C. Nearly all the goods known under the general appellation of household linen, such as sheets, tablecloths, quilts, towels, &c. Sewing thread, sailcloth, lines and cords, fire-engine hose, driving belts.

D. Coarse goods, such as sacking, canvas, ropes, twines.

After the fibre has been degummed, and in many cases also bleached, the first process it undergoes is softening. An emollient and lubricant is used to counteract as much as possible the hairiness of the fibre in the slivers, the rovings, the yarns, and the woven goods. Here I may remark that ramie fibres are naturally very unsociable. If you take half a dozen fibres in your hand, you will find that each one will bend its own way irrespective of the others. This arises from the shape of the fibre: its section, instead of being circular like cotton, partakes more of an oval form.

From the beginning to the end of the manufacturing process this hairiness has to be dealt with, and manufacturers have had to overcome many serious difficulties in this direction.

During the past thirty years a large number of experiments have been made and immense sums of money spent on the machinery and processes for preparing and spinning ramie. The results in most cases have been great loss.

Some manufacturers have tried to spin ramie on silk-waste machinery, others on flax machinery, and others on worsted and on cotton machinery. Practical experience has shown that ramie needs very special machinery for its successful treatment, and all the four trades cited have contributed machines for the purpose. Thus in the spinning of fine yarns some manufacturers dress the fibre in a manner and by machines similar to those used in the silk waste trade, but with various necessary modifications.

The preparing and slivering machines which follow the dressing are in their construction a combination of some of the machines used for flax and for worsted.

The ramie-combing machines generally used are an adaptation of an old-fashioned long wool-combing machine, with very important modifications necessary for treating ramie.

Following the combing operation are drawing frames and the roving frames, the former similar to those used in the flax and worsted trades, and the latter like those used in the worsted and cotton trades.

Opinions differ seriously as to the best assortment of machines necessary for ramie, based in part on the great variety of yarns to be spun. Some manufacturers claim that for the better and finer classes of yarn it is better both to dress and comb the fibre. For medium yarns in some cases the dressing is omitted, and combing suffices. In other cases the combing is omitted, and the dressing suffices. It is impossible to speak authoritatively on this point, as the opinions of practical men differ so much. One of the leading manufacturers produces all his yarns, even the very finest, with once combing, but he uses special combing machines of his own construction.

The spinning frames which have proved themselves to be the best adapted for ramie are the well-known Ring spinning frames as used in spinning cotton, but with important modification in order to adapt them for spinning ramie. Flyer spinning frames are also used. In some cases the spinning process is dry, in others it is wet. The latter process seems to be the most preferred, as it reduces the hairiness of the yarns and facilitates the spinning of fine yarns, care being taken that the lustre of the yarn is not affected by the water.

An important feature in ramie spinning mills is the twisting machine. In some cases the number of twisting spindles is equal to one-third of the number of spinning spindles, because there is a large demand for ramie yarns twisted several fold.

After the twisting process some of the yarns are passed through a gassing process to remove the hairiness. This process affects the lustre, but these yarns are mostly used for purposes where lustre is not essential, such as shoe threads.

Coarse and common descriptions of ramie yarn may be produced very cheaply on machinery similar to that used for flax and hemp tow. Neither dressing nor combing operations take place. The fibre is softened, then carded and formed into sliver. The slivers pass through several drawing frames in order to equalise and reduce them, then through roving frames, and the yarns are spun on ordinary spinning machines, such as are used for flax and hemp.

Before leaving this part of my subject, I must refer to noils. This is a technical term, meaning the short fibre which is separated from the long fibre by the combing machine. These are now sold at 4d. to 6d. per lb., according to the quality.

It will be seen that although nominally a waste product, they are of considerable value and importance, and there is a ready sale for them, as they are adapted for a variety of purposes. I will cite a few of them very shortly.

In certain descriptions of woollen goods the noils are mixed with the wool. The mixture is very advantageous to the manufacture, as the noils add great strength to the fabric. They also improve the appearance of the goods through their lustre and the very sound lasting colours which they take in dyeing, and they reduce the cost of the goods. It is not a case of adulteration by bringing into the mixture something that is of inferior quality, but it is a distinct improvement of the goods.

Noils are also used in the manufacture of certain description of cotton goods, and for that purpose they are spun on cotton machinery. They add great strength to the goods and improve the appearance through their natural lustre.

Noils are also being used for the manufacture of celluloid, and for use in the manufacture of certain descriptions of high-class paper.

So far from there being any difficulty in disposing of noils, experience has shown that the use for them is rapidly increasing, and more could be sold than are produced.

The natural sequence of manufacturing operations now leads me to the subject of weaving ramie, and here I may say that the looms generally used for weaving other textiles can be used for weaving ramie, as the principle of weaving all textiles is practically the same.

Important modifications in some of the details of the looms have to be made, so as to adapt them for the treatment of ramie yarns. The same remark applies to the auxiliary operations of warping and winding. The latest and most successful practice in regard to weft is to spin it direct on to paper tubes or on to the bare spindle or into cops, so that these can be removed from the spindle, and inserted in the shuttle, thus avoiding several operations of winding and rewinding.

In the case of coloured yarns, the use of which is increasing so enormously, it has been found more advantageous to dye the material shortly after it is bleached, or in the sliver. Attempts to dye ramie yarns in the hank have not proved successful on account of the hairiness and matting of the yarns.

After the goods are woven they require to pass through a finishing process, as is the case with all textile goods. This process varies very considerably according to the nature of the goods. The machinery used for finishing cotton, flax, and silk goods, can be adapted for finishing ramie goods, with modifications rendered necessary by the peculiarity of the fibre.

Having thus reached the stage of complete manufacture, a few statistics will be useful in relation to the present extent of the manufacture.

France, which was the first country to practically take in hand the question of ramie, and which has, probably, shown more sympathy with this fibre than all other countries put together, has several mills, containing in the aggregate about 12,000 spinning spindles. Amongst the French mills, I cite specially the one conducted by Mr. Favier, with 4,500 spindles. This mill spins ramie yarns from the coarsest to the finest yarns, varying in thickness from 1,000 to 35,000 yards per lb. The machinery is driven by 180 h.-p. There are about 200 workpeople, and the amount of raw material treated annually is about 300 tons. This gentleman occupies a deservedly high position in the trade, as he was one of the first to interest himself in ramie, and for many years has made great sacrifices to improve the manufacture and to urge his countrymen to a higher appreciation of the splendid qualities of this fibre.

Germany has about 11,000 spinning spindles. Amongst the German mills I cite specially the largest existing ramie mill at Emmendingen, in Baden, of which Mr. Baumgartner is managing director. This gentleman is much to be commended for the energy and talent which he has shown in connection with the business. Not only has he overcome the manufacturing difficulties involved in the treatment of ramie, but he has been the means of ramie being largely used for purposes that were never foreseen. He keeps increasing the works, as the demand for his products is daily increasing, and his concern bids fair to retain the lead as the largest ramie spinning concern there is. This mill has 7,500 spinning spindles, spins yarn varying from 5,000 to 40,000 yards to the pound. It employs 300 workpeople and it disposes of 390 h.-p. The amount of raw material treated annually is about 450 tons.

In the United States of America ramie is also spun to a small extent in two mills, but I cannot learn that they are of importance.

In England there are four or five spinning mills. The most important one is that of Messrs. James Finlay and Co., of Derby, to whose samples I have already made reference. Their late managing director, Mr. Longmore, may be truly said to excel in all the processes of manufacturing ramie, including also weaving, dyeing, and finishing. The result has been obtained by dogged perseverance, patience and great talent as an engineer and chemist. He has designed and constructed most of the machinery, has carefully studied the chemical processes involved in degumming, in bleaching, and in dyeing, and the samples before us show how thoroughly successful he has been in all that he has undertaken in relation to this fibre.

And here I must not omit a tribute of warm praise to Mr. Thiselton Dyer and to Dr. Morris of the Royal Gardens, Kew, who have for years by their knowledge and influence brought the good qualities of this fibre so frequently and so earnestly to the attention of the public.

It is not possible to give thoroughly accurate statistics of the present extent of ramie spinning, because the materials for the purpose do not exist in a complete form, but from my own knowledge, combined with information obtained elsewhere, I may mention that the total number of spinning spindles now employed on ramie is approximately 31,000. Assuming the average annual production to be 75 lbs. of yarn per spindle, it follows that the total annual production of existing mills is about 1,000 tons, exclusive of noils, and the raw material used, mostly China grass, may be taken as 2,200 tons.

The cost of the machinery for a ramie spinning mill in England, say of 5,000 spindles, with the necessary twisting, is about £3 per spindle, or including the necessary motors and shafting, electric lighting, and the necessary mill stores, £4 per spindle.

What position does ramie now occupy in the textile world? When this fibre was first brought before the notice of the public, many gross exaggerations were indulged in as to the cheap cost of its production, the enormous profits to be obtained from its manufacture, and its adaptability for almost everything. Ramie might well say "Save me from my friends."

Increased knowledge and experience enable us to place ramie very clearly in its proper place in the textile world. It can never supersede silk, but by reason of its beautiful lustre and the degree of fineness to which it can be spun, it is being largely used along with silk, and its use for these purposes increases daily.

There are many classes of goods in which the warps are cotton and the weft silk, and *vice versa*. For these goods ramie undoubtedly is the best substitute for cotton, as the manufacturer, by means of the beautiful lustre and the cheapness of ramie, can produce goods composed of ramie and silk without having to resort to the loading now so common in silk manufacturing centres, by which one pound of silk is made to weigh several pounds when manufactured into dress goods.

In some cases, where high lustre combined with low price is essential, ramie will be largely employed instead of silk, in fact is now being so employed. In addition to its lustre, it has the good quality of receiving and retaining colours freely, so that many dyed articles now made of silk will in future be made of ramie. Yarn is now manufactured in Germany, which is having a very large sale, which consists of a thread of silk and a thread of ramie twisted together. In many cases of goods, such as smallwares, laces, curtains, and upholsterers' goods, ramie is being successfully substituted for silk.

In comparison with flax, it may be said that ramie is being used, and will in future be much more largely used, for certain classes of goods hitherto made of linen, and should the price of ramie materially decrease in the future, it will, no doubt, supplant flax in certain descriptions of goods.

Ramie will play an important part, in the future, in most mixed woollen goods. It has the peculiar feature of combining well with wool, and is now being largely used for that purpose.

With regard to cotton, I do not think that the views formerly entertained of its supplanting cotton will ever be realised. For some kinds of goods, ramie is being used in lieu of, or in combination with cotton, on account of its superior strength and its more lasting qualities, but the very low price at which most descriptions of cotton goods can be produced, will always prevent cotton being supplanted by ramie.

Nothing need be wasted in connection with ramie. Even the very commonest, roughest waste can be utilised either in the manufacture of twines or for paper making.

FUTURE PROSPECTS OF THE RAMIE TRADE.

The way is now clear and open for great progress in this industry, but it must not be too readily assumed that there is going to be an immediate boom in ramie; the very nature of the circumstances attending its cultivation prevent such an occurrence. Everything points to a certain but gradual development. I do not anticipate that the cultivator will proceed otherwise than cautiously in planting and producing fibre. As soon as he has thoroughly realised that there is a ready sale for his fibre at good and profitable prices, he will doubtless increase his production methodically and energetically.

The manufacturer cannot be expected to invest large amounts in special machinery for ramie on the mere expectation of large supplies of the fibre being immediately put on the market.

The progress will be steady, and in the proportion in which the increased supplies of the fibre come into the market, will be the enlargement of existing mills, the starting of new mills, and the increased use of the fibre in all manner of goods for which it is adapted.

The trade is now on a sound and practical basis as far as immediate requirements are concerned. The supplies of China grass, though at times irregular in quantity and quality, and subject to considerable fluctuations in price, have enabled spinners to attain their present position in the market and to show to the manufacturing world what can be accomplished with the fibre.

There can be no doubt that the present situation warrants and justifies the encouragement and immediate development of ramie cultivation in all the countries, the climate and soil of which are favourable to the growth of the plant. This will ensure regular, ample and cheap supplies of the fibre from a variety of sources, and free the spinner from dependence upon one channel of supply only, viz., China.

Visionary schemes have been swept away by hard experience; our knowledge of the splendid qualities of this fibre, and the mode of treating it has grown enormously, and we may, therefore, look forward to its manufacture being rapidly increased and freed from speculation and costly experiments.

In a recent letter received from a large spinner of ramie, I was much struck with an expression he used in relation to this fibre, namely, that it is the "noblest" of all fibres. I thoroughly agree with him. It is a true description, and I have endeavoured to show that it is indeed superior in so many respects as to justify its being placed at the head of all textile fibres.

DISCUSSION.

Mr. ST. GEORGE LANE FOX said that he had given a great deal of attention to this subject for the last year or two, and agreed with the greater part of the paper, but one statement in it he felt bound to contravert. The author said it was necessary to free the fibre from the juice and skin by mechanical means before it could be treated practically by the spinner From personal experience he could say that was not so, for at the Castleton Mills, near Rochdale, a very large number of spindles employed were producing excellent yarn from the raw black rhea, chemically treated only. This was important as bearing on the question of supply which would be available. Hitherto it had been found necessary to remove the skin or epidermis from the fibre by hand before it could be degummed, combed, and made fit for the spinner. This was done in China by soaking and scraping laboriously, the result of which was that the price of China grass in the market was about £35 a ton, and the samples produced at the Emmendinjen works were produced from such material. On the other hand what was done by Mr. Gomess's process was simply to free the raw black ribbon by chemical action from the skin as well as the gum. He had seen the process in operation many times, and had had the opportunity of verifying in America, where he negotiated the sale of the patent, the truth of what was claimed for this process. No doubt there had been exaggerations and misstatements, as there always were in connection with any new matter, but it was perfectly true that if the ribbon were first soaked in a dilute solution of nitric acid, and then boiled in a dilute solution of caustic soda to which a small proportion of zinc dust was added, the epidermis came off partially dissolved, leaving the fibre practically free. It was very easy to produce ribbons, machines for that purpose having been long known, and the hand-labour required to strip off the bark did not add much to the cost even if no machinery were available. This very ingenious machine of M. Faure, however, would only treat a comparatively small quantity of fibre, and required two men to work it; and there was a danger of the fibre being injured if the machine were not very skilfully handled. If the rapidly revolving beaters struck against the fibre too abruptly, they not only rubbed off the skin and squeezed out the juice, but tended to break the fibre, which of course would detract from its value. He did not dispute that when the machine was skilfully used it was perfectly successful, and he had seen most excellent samples produced by it. It was claimed that it produced an article equal to, and probably costing as much as, hand-cleaned China grass, which was worth £35 a ton. On the other hand, the black ribbons costing only £8 or £9 a ton, though they lost 7 or 8 per cent. in weight in the process of removing the skin, there was still showed a considerable saving as compared with China grass. Mr. Barraclough had shown that there was a great future for ramie, however produced; but it was not necessary to absolutely condemn chemical processes in order to prove that mechanical ones had their value. The future of this fibre would depend chiefly on its being properly grown under suitable conditions of soil and climate, and when it was known that there was a large market for the raw black ribbons, there was no doubt it would be produced in large quantities in many parts of the world.

Mr. MACDONALD said he had heard the remarks of the last speaker with some astonishment. The price of ribbons in the market at present was £15 a ton, and they lost 60 per cent. in treatment, so that as China grass, which had had the bark removed, lost only 30 per cent., there must be considerably more than 6 per cent. of bark left in ribbons. From a commercial point of view the most important point was the cost of the raw material. These ribbons were sent from various parts, Assam for example, and the freight alone was £2 a ton, and another £2 a ton was the cost of railway carriage after it reached this country, to bring it to their factory at Long Eaton. Thus, assuming for convenience of calculation that there was a loss of only 50 per cent. instead of 60 per cent. in treatment, this made £8 a ton on the product for carriage, and what industry in the world could stand such a charge as that? It was all very well for gentlemen interested in public companies to endeavour to foist these things on the public, but the truth ought to be stated. He had endeavoured to do so again and again in the public Press, and he quite agreed with Mr. Barraclough that the worst friends of the ramie industry were those who tried to prove that it could be produced for next to nothing. M. Faure was certainly on the right track, for as Mr. Barraclough had said, the proper thing to do was to produce the material free from gum and bark, and as nearly as possible fit for spinning. We should go farther, and say that it ought to be decorticated by machinery and treated on the ground where it was grown. No one could make money out of it by importing it in the shape either of China grass or of ribbons. Immediately the industry started, he made contracts for the supply of goods based upon a certain cost of the raw material; but the price had been so enhanced, that many undertakings, which had been started under the best possible auspices, had been ruined. His firm, the Midlands Spinning Company, of Long Eaton, were the largest manufacturers of ramie in this country, and when they first started they got China grass at £22 a ton, and ribbons at £12. Now ribbons had gone up to £15 and China grass to nearly £35, nad at these prices, it was impossible to carry on the business at a profit. The filasse came out at about 8d. a lb., double the price of cotton, and unless it could be brought down to something like the price of cotton or flax, it was impossible to make any profit out of it. They had been working at it three years, honestly and straightforwardly, doing their best to bring it under the notice of manufacturers; but the result of prices going up so much was that they could only sell cwts., where they would otherwise dispose of tons. He was, himself, the inventorof a decorticator, and though he gave M. Faure the credit of being the first in this direction, he had not gone far enough; he ought to send the material to this country in the form of filasse, ready for the manufacturer. He should like to ask if the yield of 14 to 18 tons of ramie per acre meant per crop or per annum. He might also mention that it was a mistake to suppose that any special machinery was required for spinning this fibre; either silk or woollen spinning machinery was sufficient for all purposes. That was his experience, and they had the command of the Nottingham market for the lace trade, which was a sufficient guarantee that their yarn was of the best quality. The ring frame was not the best adapted to it, as it tended to fray the fibre.

Mr. E. CASPER said a paper like this, followed by an intelligent and practical discussion, was of the highest importance. He held in his hand the first patent of any importance taken out for this matter, viz., that of Prof. Frémy, of the Institut de France, in whose laboratory he had worked and afterwards bought the patent. He treated about £10,000 worth of material imported direct from China. On the faith of reports by the highest authorities on patents, he bought the patent for a large sum, and he and his friends invested £12,000 in developing it, which unfortunately turned out a dead loss. China grass was ruined by treatment with machinery of any kind, or with chemicals. They thought they were treating it properly. He spoke in public respecting rhea, in Manchester, and disposed of a considerable quantity of fibre, but within twelve months writs began to pour in on the manufacturers who had used it, because the goods, beautiful as they looked at first, became rotten. The consequence was they sold off the whole of the remaining stock with all faults, and abandoned the process. He quite agreed with what Mr. Macdonald had said, but he (the speaker) could lay down this stuff in the form of filasse at 4d. a lb. of the highest quality without the use of any machinery, and without a particle of chemicals. The greatest portion of the cost went in charges, which in no way affected the material. The stuff which gave all the trouble is, when cut, in a semi-fluid state; as soon as cut it should be tied in bundles, put in wooden boxes made on the ground, and steamed, which could be done by a portable boiler drawn by a donkey. The gum, then semi-fluid, became liquid, and girls, who were paid about 2d. a day in India, drew off, in the form of ribbons the fibre which was enclosed between two protecting walls. He had spent a good deal in machines but found none of them satisfactory. This fibre would not stand any bruising, and even when not apparent there was often an incipient bruise, which would have a prejudicial effect in spinning. In each stem there were three or four grains at most of valuable matter, and he would defy any machine he had seen not to leave at least one grain on the stem, which was 25 per cent. of the valuable portion, and the beating by the machine had also a tendency to cause splintering. His patented process comprised the hanging the ribbons on wooden frames and exposing them to an artificial rain for a considerable time, by which every particle of foreign matter was removed, and filasse of the most beautiful quality was produced. By this method no skilled labour or machinery was required. He had not seen M. Faure's machine, which might be an admirable one, but all these machines reminded him of the old tale about the marvellous invention which was submitted to the French Institute, and a committee was appointed to examine it. They reported that it was a novelty, and of great merit for the purpose intended that of cutting cabbages, and that it could only be excelled by an ordinary knife. In the same way he contended that where native hand labour could be obtained at rates quoted above it, was simplest and cheapest. He paid 30s. or 35s. a ton freight from Hankow, and though they did their best by compressing the ribbons, this could not be carried too far, or they formed one solid mass, which resisted all attempts at treatment; and the result was, the cost of carriage came to about £14 or £16 per ton of filasse. Treated as he had indicated, he maintained that filasse ready for combing could be sold at 4d. a lb., and yield a good profit.

Mr. W. T. WRIGHT said he had given some attention to this subject for the last year or two, and had been much interested in the paper. He hoped the attention now given to the matter would result in the industry being put on a sound footing, for hitherto there had been a good deal of fiction about, and owing to exaggerated statements, unreasonable expectations had been formed. His firm had tried to use rhea fibre, but, owing to there being a loss of some 55 or 60 per cent. in weight, they found it more expensive than the higher priced China grass, on which there was only a loss of 25 per cent. in treatment, and it gave better results in the form of spun yarn. The machines designed for the extraction of the fibre, even M. Faure's, did not come up to their expectations in the matter of the weight turned out. Unless the beater blades were very carefully adjusted, there was a danger of the fibre being injured, and two men were required to work the machine. A quantity of China grass had been bought that week at £27 a ton, while the price of rhea was £15 to £16. When acids and strong caustic alkalies were used, they injured the fibre, unless they were thoroughly washed out; but weaker preparations were now employed, and they had not proved so injurious as they had been told, though, of course, any excess would injure both the fibre and the woven fabric. They found no difficulty in treating China grass, nor in spinning it with an ordinary worsted machine. Simple solvents for the gums could be discovered from any handbook on chemistry, and they found no difficulty and made no particular secret of their processes. After some 18 months' experience, he did not think the practical difficulties need alarm business men; his only fear was that when its properties were better known, the supply would not keep pace with the demand. What was most wanted was to get people to cultivate it where the soil and climate was suitable, and to degum it on the spot, so as to save useless freight charges.

Mr. GOMESS said there was no doubt that strong acids and caustic soda were injurious, but with a judicious use of chemicals, no deterioration need take place. The most economical source of supply would be the black ribbons.

Mr. LANDON asked whether the specimens exhibited by Messrs. Finlay and Company and Messrs. Baumgartner were produced from the ribbons, or from China grass.

Mr. MARTIN WOOD said he could only speak on this question as one of the general public, and he thought one lesson to be derived from what they had heard was that in all new departures of this kind, great care and patience were required. For thirty years, or more, efforts had been made to bring the valuable fibre to practical account. He remembered when Lord Mayo was Governor-General of India he offered handsome prizes for machines which would decorticate and degum this fibre so as to fit it for the market, but nothing came of that. He had hopes, however, that the cultivators of India would benefit by the demand for rhea, if that could be established in western markets. At one time the idea was that it would grow anywhere in India, and when this proved to be a mistake, some people went to the other extreme and said it could only be grown in Assam; but he hoped the plant would be found to grow in two or three other provinces of India. Still English capital and skill would evidently be required if anything considerable were to be accomplished; though he agreed in the advice given by Mr. Casper that as far as possible native labour should be utilised on the spot. As to the task of bringing rhea to public notice, and promoting its utilisation, the Society of Arts had done its share; and he trusted the exhaustive paper just placed before them might go far towards bringing this beautiful fibre into general use.

Mr. D. W. WATT said he had just come from South Africa and was just returning there, and as he had been approached on the subject of growing rhea, he should be very glad of a little more definite information as to its value. At present he was rather confused, for while one gentleman put it at £15 a ton, another put it at £8, and he wanted to know before he started which was right. He was not in a position to discuss either chemical or mechanical processes; he came in before either of those were required, but before starting planting he wanted to know whether the statements which had been made that evening could be guaranteed. He thought no statement should be made at that institute unless they were guaranteed.

Mr. BARRACLOUGH, in reply, said he thought Mr. Lane Fox had slightly misunderstood him; both China grass and Assam ribbons could be treated chemically without any patent, and he had made no comparison between different patent processes. What he said was that if you imported the ribbon yourself as Messrs. Finlay and Co. did, you could do what you liked with them, if you understood chemistry. You could not go into the market and buy them as a regnlar article of commerce. The great drawback to treating them in this country was the great cost of freight, which was calculated by measurement, and there was so much loss in the process. He thoroughly agreed with Mr. Macdonald that the degumming should be done on the ground. He did not, however, recommend growers to begin doing this at first, because at first it seemed a little complicated, and they lost courage. He told them to grow the fibre for a year or two, and send it into the market, and then when returns began to come in, to put down a simple degumming plant, and send out merely the fibre. The price of China grass had been put at £35, but he knew that Mr. Longmore and Mr. Baumgartner purchased it direct in quantities under contract at £25 or £26. He had been anxious to keep clear of any particular machine or process. His invention was not in the machine but in the fibre. No doubt other machines would be invented which would do more than Faure's, though Mr. Wright's notion about it was not quite correct; the fibre resulting from it was degummed and combed. If this fibre were badly treated the combing machine showed it at once. With an ordinary machine there would be 75 per cent. long and 25 per cent. short fibre, but if it had been at all bruised the long fibre would be as low as 50 per cent. It had been stated that no special spinning machinery was required, but he should be supported by two of the greatest authorities in saying that anyone who tried to manufacture this yarn with ordinary silk or woollen spinning machinery would never make 1d. profit by it. It was a special fibre that could only be properly dealt with by a special machine. With regard to a guarantee of prices, he did not think there could be said to be a proper market for ribbons; there had been lots which had remained seven years unsold, and then when there was a little curiosity excited about it, they would be bought up at any price for the purpose of experiment. There was no such thing as a merchant having 100 bales which he could sell by sample, because there was not a manufacturre who could make an offer except at an absurd price. This was because, when you got a bale, you could not tell whether you were going to lose 40, 50, or 60 per cent. in the treatment; therefore he could not fix a price. In order to develop a trade the raw material must come in a form like China grass, when an expert could see what he was buying and fix a price accordingly. With regard to the materials used in the specimens shown, Messrs. Baumgartner used China grass and ribbons, and so did Finlay and Co., the ribbons being of their own growing; and they told him that the goods they made were equally good, and they used them indiscriminately. The crop per acre he mentioned on the authority of the growers was for the whole year.

The CHAIRMAN, in moving a cordial vote of thanks to Mr. Barraclough for his paper, said the chief impression left on his mind by the discussion was that there was a great difference of opinion, but such differences might in the end be useful. It was evidently very important, if this industry were to flourish, that there should be a tolerably certain supply, and the cost must not be excessive. Though it had certain characteristics resembling silk, it could not compete seriously with silk; so that, in price, it must compete with cotton. Everyone would agree, on general principles, that as much of the preliminary treatment as possible should be done on the spot, if only to save the cost of freight. It was now some twenty years since attention was first called to this product, and if no very great things had yet been done, still, as Mr. Wood had said, it may be well still to have patience. Ramie certainly had qualities which appealed very strongly to anyone who had a knowledge of yarns or textiles. He had been told by a friend who was a silk merchant, that for some years he had experienced a regular though not a large demand for it; though as he was only an intermediary he did not know what it was used for.

The vote of thanks was carried unanimously, and the meeting adjourned.

Sir GEORGE BIRDWOOD writes as follows:—I declined to speak in the discussion on Mr. Barraclough's invaluable paper, chiefly because, as was inevitable, it at once became a sort of exploitation of the comparative merits of the various machines and processes which have, during the past twenty-five years, been competing for public recognition. This discussion was most instructive, but I felt it undesirable to join in it while in actual progress, and that it would be better to reserve what I might, without objection, say on the subject, for a written addendum to the report of the paper, and discussion, in our *Journal*. To me it seems, that the great rhea problem of the moment is, not to produce a perfected machine, or process, for the manufacture of the fibre, but to find a constant and cheap supply of rhea for keeping the machine, or process, in profitable operation. In my humble opinion there are several machines and processes sufficiently good for preparing the fibre for the use of the textile manufactures of Europe and America; but the pressing problem is the reserve of rhea. In Mr. Barraclough's thoroughly practical paper we for the first time find some reliable data as to the quantity of the fibre now being consumed in Europe. I was quite unprepared for so large an employment of it. He does not say how much of it is Indian, which I would distingush as "Rhea," how much of it comes from the Indian Archipelago, which I would distinguish as "Ramie," how much from China which has always been distinguished as "China grass," or how much of it is derived from the Chinese, Malayan, or Indian varieties of the plant cultivated in various countries of the West. I know that very little of it can be rhea imported from India; and that, once again, as in the case of "Tusser silk," an enterprise instigated by the Government of India, is resulting in benefit to some other country or countries rather than to India itself. I suppose also from what Mr. Barraclough says as to the uselessness of cultivating rhea (and I presume he includes ramie, and even China grass in the condemnation) outside tropical and sub-tropical countries, that little or none of the fibre now being utilised by the manufacturers of the West is prepared from rhea grown in Europe or North Africa. I cannot, however, at once accept Mr. Barraclough's conclusions on this particular point. I myself experimentally cultivated Assam rhea in the Bombay Presidency, and as a mere question of acclimatising the plant, without any reference to the quality of its fibre, I found it would grow naturally everywhere, from beyond the top of the ghâts (Balaghât) to the sea shore of Bombay, and under every condition of climate and cultivation found within these limits. In the Victoria Gardens, Bombay, where it was constantly watered with the other plants, it flourished luxuriantly, and required constant cutting back to keep it within bounds. I am told it is a very exhausting crop, but I do not remember to have observed this of it. Then, all the rhea used for Dr. Forbes-Watson's experiments was grown by the second Duke of Wellington at Strathfieldsaye in Hampshire. It is being experimentally cultivated in the Limousin by M. Faure, and I believe in the Pas de Calais by the English founders (Mr. John B. Whitley) of Mayville. The French Government are giving great attention to its introduction into Algiers. The cultivation of rhea is also being tentatively carried on in Germany, where it is reported to well withstand the winter; and even in Spain: and only during the last few weeks I have heard of its extensive cultivation in the Caucasus—where it gives three crops in the year—by the Princes Murat. In the Americas the plant has been experimentally grown not only in Venezuela and Jamaica, but in the United States (Arizona, &c.); and where it flourishes so luxuriantly in the Indian Archipelago, as at Malacca, and Johore, and in Sumatra, and Borneo, it is really all of Indian origin. In short, the cultivation of rhea seems to succeed everywhere, whether in the tropics, or the the north temperate zone, except in India, its native habitat. My own conclusion therefore is that it will thrive everywhere in an agricultural sense, and that for manufacturing purposes, you are likely to get a finer fibre [not larger or stronger] from rhea raised in the north temperate zone than from rhea of tropical production. What is the exquisite "China grass" but rhea of the north temperate zone: and ramie is rhea of the tropical zone, while the original rhea of Assam is a native of a northern sub-tropical region. As to rhea machines and processes, in my opinion, all chemical processes are excluded from consideration. The water process is ideally the best, but experts urge the impossibility of working it advantageously, that is, on a really large scale, unless under circumstances so exceptional as to exclude it from the serious attention of any but those who are masters of, and practically monopolise, the exceptional situation postulated. We have therefore to fall back on some machine; and a machine for operating on the stems as freshly cropped, and with as little crushing, particularly by repeated blows, as possible; and which will turn out the fibre, not in the chemically prepared form of "ribbons," so difficult to grade and price, but in the form, already familiar to the markets of the West, of "China grass." Of course the manufacturers of the West do not care from what countries they obtain their "China grass," or "Ramie," or "Rhea," whether Algiers, the Caucasus, India, the Indian Archipelago, China, or the Americas, or Southern and Central Europe; but intervening, as I do in the question, in the interests of India, I cannot but regret, with the easy wisdom of 27 years after the event, that the reward of £5,000 offered by the Government of India, in 1870, was for a machine or process to furnish rhea fibre at £15 a ton, and not for the experimental cultivation and improvement of the plant. It is haply not too late to do something in this way now, and I would fain hope something may be done, and that heavy premiums may be offered to ryots, and others in India, to experimentally cultivate, in selected districts in Assam, Bengal, Cashmere, the Punjaub, Scinde, Central India, Bombay, and Madras, every possible variety (or species) of rhea to be found in India, or outside India, and to submit the results of the experiment to an officially appointed committee of scientific, technical, and mercantile experts. At least 500 acres should be devoted to these experiments, which should be carried on for at least five years. The great obligation, that is from my point of regard, is to secure to India the supply of the increasing demand for rhea fibre by manufacturers in this country, and on the Continent, and in the United States of America; that is to solve the great rhea problem of the moment, as I understand it, in favour of India. Mr. Barraclough's paper proves that there is a clear prospect of possible commercial supplies of the fibre from sources altogether outside India, and this is a fact of supreme importance for the people of that country, and full of significance for all those responsible for advising the Indian Government in such matters.

SIXTEENTH ORDINARY MEETING.

Wednesday, March 31, 1897; Lord BELHAVEN AND STENTON, Member of Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Bowen, Horace George, Bank of England, E.C.
Chalmers, George, St. John del Rey Mines, Morro Velho, Brazil.
Elliott, George, 10, Oceanic-avenue, Belfast.
Fortlage, H., Breakspeare-house, College-road, South Dulwich, S.E.
Rabbidge, Richard, 32, Poultry, E.C.

The following candidates were balloted for and duly elected members of the Society:—

Ashley, Right Hon. Evelyn, 13, Cadogan-square, S.W.
Eastlake, Arthur William, Fairlawn, Temperley-road, Balham, S.W.
Goulding, Frederick, Kingston-house, Shepherd's-bush-road, W.
Hentschel, Carl, 182, Fleet-street, E.C.
Osborn, Ashby Frederick, Cowra, New South Wales.
Smith, Edward, 75, Gore-road, South Hackney, N.E.
Xavier, Isidore M., Water Department, Victoria, Hong-Kong.

The paper read was—

CYCLING:
HISTORICAL AND PRACTICAL.

By GEORGE LACY HILLIER.

I propose this evening to give you some little history of the development of the sport of cycling, and of the machine as we now know it, and possibly one or two practical hints, although the subject is so wide that I think I shall detain you longer than you ought to be detained if I enter fully into it. Before I deal absolutely with the sport, I should remind you that we live under very favourable circumstances indeed in the matter of roads. It is only within comparatively recent times that our roads have been rideable, and I have got together a few facts to give you some idea of the disadvantages the earlier inventors of what they facetiously termed "self-moving carriages," laboured under when they began to experiment with their vehicles.

There is a village in Lancashire where the news of the battle of Waterloo arrived in consequence of the badness of the roads exactly twelve months after the fight was over.

Early in the 18th century it was not unusual for travellers to be detained for weeks for a guide through the dangerous parts. A Viceroy going through Ireland took five hours to cover the 14 miles between St. Asaph and Conway, and it was usual for carriages to be taken to pieces and carried by strong countrymen across Wales to the Menai Straits. As regards the county with which I am personally connected, Sussex, its roads were so very bad, that whenever a particularly bad piece was struck anywhere else, they called it "the Sussex bit." There is a tradition in the country that the tallness of Sussex girls is due entirely to the fact that they had to exert great strength in pulling their feet out of the mud, thereby lengthening their limbs.

The poet Cowley retired to Chertsey, and wrote to his friend Sprat, inviting him to go and visit him, and encouraged him to undertake the journey by saying that he could sleep the first night at Hampton town. The distance was 22 miles, and he thus was to take two days for the journey.

In 1703, Prince George of Denmark, the husband of Queen Anne, went from Windsor to Petworth, 40 miles, which occupied 14 hours, and the veracious chronicler of the period says that the Prince never left the coach, except when it was upset or stuck in the mud.

The mail from Edinburgh to London took six days, and it took two days to get from London to Tonbridge Wells, three days to Oxford, and five days to Exeter; whilst King George II. and Queen Caroline journeying from Kew to St. James's took the whole night, and were upset in the mud in the course of the journey. In short, in the 17th century London was further from Reading than it is from Edinburgh to day. It was further from Edinburgh than it is to-day from Vienna, and our roads from the period of the introduction of the stage coaches—have been rapidly improved. Telford and Macadam were the men to whom the excellence of our highways are due, and the growth of coach traffic kept them in good condition. Comparing our roads with the roads abroad, the excellent bye-ways and lanes found in England are specially noticeable. If you go abroad, in France, for instance, the bye-ways other than the national or departmental roads, are very bad indeed; whereas there are some cyclists present who probably know that in England lane riding is one of the most pleasurable branches of English cycling.

I now propose to show you some of the ancestors of the cycle of to-day, but I shall begin by throwing on the screen representations of some of the facetiously termed self-moving carriages which were arranged at an early period.

This I believe to be Blanchard and Mesurier's carriage, which was shown to King Louis XVI. The gentleman in the carriage is engaged in steering, and the person behind is driving by means of levers and springs and cog wheels, which are concealed in the box. This was copied by an inventor in England called McDonald, and he writing to the "Mechanics' Register" of the period said: "You may think perhaps the man behind has hard labour; not so! Owing to the velocity of fly-wheel, he has but seldom to put his foot to the treadle." I have always held a particular desire, which has never been gratified, to have the view of "the man behind."

The next picture is that of the Bolton machine, which is calculated to carry seven people. There are many points about it which show how ingenious was the inventor. I draw your attention first to his immense talent in putting the person who is engaged in propelling the machine with his back to the direction in which he is travelling. If he had looked in the direction in which he was going, he might have been somewhat discouraged. Although the machine is geared to about five inches he would want all his power to propel it when fully laden. I do not know how much power would be required, but I should think 10 h.-p. would be required to move it on the level, and I do not think any human force would enable it to go up hills unless the riders got off and pushed it. There is no provision for a brake.

Before I show you the next picture, I may say we have arrived at the point where the bicycle practically starts—the first invention which has led up to the bicycle of to-day. It was the invention of the Baron von Drais, of Frankfort-on-Maine. His machine was ridden in the Tivoli-gardens, Paris, in 1817. This is practically the Baron von Drais's machine, and it was called the "Draisenene," or "Dandy Horse." It got this latter name when the Dandies rode it in England. In one or two pictures which I shall show you it was described as a "hobby horse," but the hobby horse as mentioned in Shakespeare has nothing at all to do with the dandy horse.

In 1818, the dandy horse was introduced into England. This was the very latest improvement, the Dennis Johnson bicycle; it was made by Dennis Johnson of Long-acre, and is a reproduction of the Baron Von Drais's machine. I draw attention to the chest rest. A year or two ago an ingenious inventor, with a great flourish of trumpets, brought out a chest rest for cyclists by which he said you got 25 per cent. more power; and he was somewhat annoyed when a member of the North Road Club inquired whether, if you had two chest rests, there would be a saving of 50 per cent.

The next picture is that of a dandy horse which is still in existence at Alnwick, and belongs to the Duke of Northumberland. It is absolutely rideable, though its date is 1816. The Duke of Northumberland of that day used to ride it a great deal, until he fell down the grass slope, and the dandy horse fell on him, after which it was put into the museum.

The next picture shows the method of propulsion. The rider strikes with his feet on the ground, a kind of running action. and he leans forward on the chest rest. I have a contemporary caricature, which illustrates the same thing. The wits of the period said "The dandy rides in his carriage, and walks in the mud at the same time."

Before I show you the next picture, I must tell you there was a great deal of doubt and vagueness of detail as to the next step in the history of the bicycle. The dandy horse existed, and for a long time nobody traced its gradual development to the bicycle; but at one Stanley Show, there was shown a dandy horse with rear arrangement of levers, which was the property of Gavin Dalziel, of Keir. He was credited with being the absolute inventor of rear-driving, as adapted to the dandy horse; but a gentleman named Mr. James Johnson, of Glasgow, set to work to find out the real history. He found contemporary records, and he succeeded in proving that the credit had been improperly given to Gavin Dalziel, and that it really belonged to Kirkpatrick Macmillan.

This is the first time in cycling history that evers and rear-driving were adopted. Here are the cranks adapted to the rear wheel, and there is a lever on a dropping bar, the rider sitting on the seat and pushing the levers. Altogether it was a most marked advance, and was practically the first rear-driving machine in this country.

History repeats itself in some degree. Here is a gentleman mounting from the ground. He is riding an improved machine by Kirkpatrick Macmillan. This is Thomas McCall, and he rode this machine for many years.

I will now show you the portrait of the first inventor, Kirkpatrick Macmillan, who died in 1876. He made a vast number of machines, of which we are constantly finding records and pictures. This was an improved specimen of Kirkpatrick Macmillan's bicycle. He had gone to greater lengths than he had in the earlier stages, for you see he has replaced the chest rest. The saddle had a spring and there was a mud guard over the rear wheel. He introduced two levers and strengthened the forks. In short this was a highly improved machine of its type.

We can trace Kirkpatrick Macmillan down to 1845, but after that nobody seems to have improved the rear-driving dandy horse which he had made, and it is not till 1866 that we hear of any further development, and then we find it in a child's toy in Paris. It was a little tricycle with two wheels side by side, and a driving wheel in front fitted with pedals. In course of time this toy took the form of the two-wheeled machine fitted with pedals. It was seen in Paris by Mr. Rowley Turner, who is connected with the cycling trade in Coventry. Mr. Rowley Turner purchased one of these strange machines, and brought it to London; he took it to the gymnasium of Charles Spencer, whose name was connected with cycling from the first. Charles Spencer claimed to have taught Charles Dickens to ride, but he was in error in that respect—it was another gentleman, Mr. J. C. Parkinson, who is still a cyclist, whom he taught. This machine brought over from Paris was unpacked in Spencer's gymnasium, and was ridden round by Mr. Turner, to the great astonishment of everybody who saw him. Amongst those present was Mr. John Mayall, jun., of Regent-street. The machine was practically a reproduction by another firm of the Lallement bicycle, and it will show you practically the first bicycle. This was made in Paris, and was simply an enlarged copy of the juvenile toy to which I have alluded.

In 1867, the first bicycle was illustrated in England. The Lallement machine had been seen by many, and a description of it appeared in the *English Mechanic*. You will observe that alteration has already been made in the pattern of the frame so as to get sufficient strength and to hold up the hind wheel. This picture gives us an idea of the pedals. They are curious in some respect, as they are adjustable, a point which has not been kept up of late.

I will now show you a portrait of John Mayall, junr., the first long distance rider, and the costume in which he rode. Mr. Mayall learnt to ride this marvellous bicycle, and he determined that he would ride from London to Brighton. Early in January, 1867, he went out to Clapham on the Brighton road, and after having ridden 17¾ miles he gave up the task absolutely and completely beaten, and came back by train. A month later he started again with four companions, and he managed to reach Brighton, though how long it took him I don't know—I believe it was fourteen hours. As the Brothers Chinnery walked down some time later in eleven hours, the novelty was not very great.

I will now take you shortly through a series of machines which show the development. The first is a bone-shaker, which took the first prize at the Crystal Palace Exhibition in 1868. It was a considerable advance on the juvenile bicycle, being fitted with a brake; there was a long spring, and the pedals are like enlarged sewing reels. That is the early English make. You see a good many points about this which show how very soon the Coventry mechanics took hold of it from a practical standpoint. They fitted an adjustable pedal. This is dated 1868, and it is the first instance of an adjustable pedal.

Here is an English-made machine of 1869. You will see it is fitted with a step, which was one of the great advances made by English makers. All the French machines had to be vaulted on to, but the English makers put a step so as to enable the rider to mount with greater ease. They also had a brake, though there was no lamp. Leftwich's specification is only curious because it deals with the difficulty of mounting. Mr. Leftwich's specification enables you to put the saddle lower down when you wanted to get on, and when you were on it rose up. It was useful to scare dogs with when it slipped down.

The next picture shows a wooden-wheel machine of 1870. I show it for this reason, that John Keen, years afterwards, invented a single-back fork, with a pin sticking out of it, carrying the rear wheel, and this anticipated that idea. The spring was brought down on to the back pin, instead of it being carried on the back stays. This is the first suggestion of the Cliptail spring.

The next picture shows an early effort to improve the steering of the bicycle, and it was improved to such a vast extent, that few people could sit upon it. On one occasion I rode one of these bicycles over a sea wall at Southampton, and fell 10 feet below on to the shingle. This is an early specimen of a wire-spoked wheel.

The next picture represents an early bicycle of 1872. It is an historical machine in one sense, because upon it Honeywell, of the Surrey Bicycle Club, won the Amateur Championship. You will perceive that the back wheel is getting smaller, and the front wheel larger. This is one of the earliest wire-spoke wheels, and it is called the Ariel bicycle. The spokes were carried through loops and brought down into the hub of the wheel. The hub of the wheel had two arms and these bars came through the ends and were screwed up by a nut.

Now I am sorry to tell you I have a gap in the pictures, because the Ariel is dated 1875, and in 1876 Henry Bate invented a machine which he called the "Flying Dutchman." This machine was unquestionably the predecessor in almost every respect, except the chain driving, of the rear driven cycles of to-day, but although I have tried very hard I have been unable to get a contemporary picture of the machine. I do not want to show any fancy drawing of it, but I can affirm that Henry Bate really invented the rear-driven cycle of to-day. He brought together rear-driving, gearing up; he adopted almost a diamond frame; he drove by means of an inextensible band; in short, with the exception of the chain, Henry Bate practically invented the machine which we have to-day.

The development of the cycle went on from this period, and in due course the safety was invented. It went steadily back in the direction of the old dandy horse. It was first made with a small front wheel and a larger driving wheel. Some were made with levers, but it was not until the chain was fitted, and gearing-up once again brought in, that we had a practical safety bicycle. What the pneumatic tyre has done for the safety bicycle I need not tell you, but before the pneumatic tyre came along, the safety bicycle was making its mark in a very steady way, and the man who made the safety bicycle a real success was Mr. J. K. Starley, of whom I will show you a portrait.

I have shown you thus far the history of the cycle, and I have shown you the men who had to do with making it. I now propose to show you some ingenious things which inventors have put before the public.

This is a Bramley and Parker's specification. It is a carriage to be driven by two men. One gentleman is steering while he is treading on some levers, The other gentleman is in an uncomfortable recumbent position, and he also is treading on some levers. I am not quite sure whether the expression, "Lying down to one's work," is derived from this machine, but it might very well be. This is dated 1830, just after the dandy horse appeared, when some attention was given to it. I have not been able to find out what happened to the machinery, but I have arrived at the conclusion that it does nothing but drive the machine.

The next one is a French patent—A. Jullien. The method of driving is extremely simple, but I cannot say as much for the balance. The driver trod on the points alternately which revolved the wheel. If there is any old cyclist present he will see that the small wheel behind is an anticipation of Carter's trailing brake.

The next picture is a curious thing; it is a continuing propeller. It is a child's toy, and it is not the first time the cycle has taken a hint from children's toys. The statement that this method of driving is an anticipation of rear-driving is a mistake. The boy rocked the horse, and the connecting rod worked up and down, and drove the rear wheel.

The next picture represents the invention of W. Moore in 1864. As far as we can understand the arrangement, there are catches, and the rider pushed his feet backward and forward and drove the wheels. It was a 4-wheeled cycle. You will see there is a wind shield on the machine, but I can hardly imagine the rider would move at such a pace as to require that shield.

The next picture represents a peculiar idea which periodically occurs to inventors; it is a rocking tricycle. Here is a chair and the rider was to rock the chair backwards and forwards and so drive the machine. If he was going any pace I should think the great coat would be superfluous.

The next picture exhibits an idea for manual propulsion which has been used by a well-known cyclist, C. C. Fontaine, who had a hand arrangement on the handle bar. It is dated 1869.

The next picture looks like a complicated variety of the Otto bicycle, but this gentleman claimed for his patent that he would be quite safe, and that there would only be two tracks. He shuts himself up pretty considerably, including a place to rest his neck in. In the specification he very carefully provides a method of walking the machine down hill, which shows distinct sense on his part—he thought it was advisable to walk down hill.

The next slide represents a tandem made according to Wortmann's patent.

The next is a velocipede by Hoak, which the rider works with his arms on cranks, driving the wheels. The only observation which the author of the book from which the picture is taken makes with regard to this photograph is that it is a pity the draughtsman has provided a man with such marvellous legs when they are only used for steering.

The next picture is that of a tricycle. The lady is steering the machine, and the dogs, on the principle of the turnspit, propel it. The comment of an American writer is very dry. He says he hardly sees how the combination of a 120 lbs. woman, a whip, and two 40 lbs. dogs, can result in progression.

I now show you a newspaper cutting dated 1846, and is the very first public contemporary notice of the pneumatic tyre. The brougham was driven in the parks, and was fitted with indiarubber tyres in a case, which could be blown up to any degree of tightness required. It is extracted from the "Mechanics' Magazine, Museum, Register, and Gazette."

I have now shown you all the pictures which I have, and I will simply recapitulate the chronology of the sport as far as we know to the time when the safety bicycle was practically developed. In 1815 the Draisenene; in 1840, Kirkpatrick Macmillan; in 1876, Henry Bate's; in 1878 Mr. J. K. Starley centrally applied a chain; and in 1884 he introduced the Rover cycle. Of course, I could have shown you a large number of photographs of ordinary bicycles; but I have not done so. I believe some specimens of up-to-date machines can be seen downstairs, and that brings us down to the point at which I have thought fit to stop.

As to practical hints I might talk to you for a very long time, and simply say what most of you already know, but there are two or three points which I will address practically to the novices present, or those who are beginning cycling. First we come to the question of attitude. Attitude is yet a matter of fashion, as far as my observation goes, amongst the large number of novices. To begin with, those who ride in the parks, sit very low with their handle very high up. There was a suggestion that they copied the familiar child's toy, the monkey-on-a-stick. Now, as far as my observation goes, others have gone to the other extreme, and I think a great many of the riders are sitting very much too high, and have their handles decidedly too low. As to the height of the saddle and the question of crank throw, that brings in the illustration I gave you just now of the expanding crank. Every individual has a particular position which suits him, and you cannot lay down a hard and fast rule. Some people like to be a little nearer the pedal, some very much farther off than would appear to be right, but you can work this out for yourselves by remembering that when you are going to strike a blow you can give it no force if it is beyond the length of the arm, and you deprive it of a great deal of force if it is very much short of the length of the arm. Exactly the same thing applies to the pedal of a bicycle. There is a certain length of crank and a certain height of pedal out of which the individual rider will get the best results, and it is for every rider to find out for himself that particular adjustment. On the question of dress I have not much to say, because I think that has been specialised in exactly the same way as the cycle has. There was a time when it was extremely difficult for a cyclist to get practical garments for use. Nowadays everybody is ready to provide them, and you have only to take what they recommend you to do.

On the economical side as opposed to the pleasure side of cycling, there is a tremendous future for the sport. You see carrier tricycles running all about the City; the cycle is being used in delivering telegraphic messages, and in connecting various places for message purposes. The cycle is much used in Coolgardie, Western Australia, for carrying messages, and during the last Matabele war two dispatch riders were riding bicycles with pneumatic tyres from Buluwayo to the field force operating against the Matabeles in the Motopo hills, and as forage was very scarce and the horses almost starving, the bicycles, practically, did the whole of the work. On one occasion, one of the riders, a well known racing man at the Crystal Palace in the old days, started from the field force to ride 70 miles to Buluwayo with a message. He started two hours after the horsemen, and got in two hours in front of of them, owing, no doubt, to the horses being so weak from want of forage. The other rider, who was dispatch riding for Earl Grey, did a somewhat similar performance. The natives whenever they saw a bicycle approaching ran away, the hostile natives as well as thefriendly. Their opinion was that the natives took it for a new sort of Maxim gun, and thought it best to give it a wide berth.

I am often asked the question as to the future of the sport. My opinion is that we are only at the beginning of it. The sport has been growing for a very long time, and it has been so perfected that I think every new rider who takes to it to-day is astonished to find to what a pitch of perfection the machines, details, and accessories have been brought. We cyclists for many years suffered from a phrase which was used in connection with us by "Atlas" of the *World*, the late Mr. Yates. He dubbed us "Cads on Castors," and that appellation stuck, and for a long time it was thought *infra dig.* to ride a bicycle. I have myself been a rider twenty-two years, and I can assure you it is only within the last five years I have not come across people who apparently expected me to be rather ashamed of being seen on a bicycle. But for the future nobody will be able to say that it is "caddish" to ride a bicycle. A change has come, and everybody now, if they are not already riding, will have to ride. In fact, in due time steps will be taken to make pedestrians wear a red light behind, and carry a bell, so as to give proper warning of their approach. When everybody rides, we cannot really have pedestrians interfering with the comfort of cyclists in that way, and I look for a great development from this time onwards.

I do not think I have anything more to say to you, except that I have been very pleased to show you these pictures, and to give some particulars concerning them. I am delighted to have had an opportunity of addressing you here in the Society of Arts, because I think it shows that our sport has made yet one more step forward in popularity.

The following Machines and Appliances were shown in the Library.

THE HARVARD MANUFACTURING COMPANY, 16, Princes-street, Hanover-square, W.

Wolff's American Lady's Bicycle.
" " Duplex Cycle.
P. and A. "Banner" Lamp.
Cycle Parts.

BRITISH "PATTISSON" HYGIENIC CYCLE SADDLE COMPANY, 200, Piccadilly, W.

"Pattisson" Hygienic Saddle.

THE LEATHERIES, LIMITED, Birmingham.

Lowenthal's Anatomical Cycle Saddle.

D. MASON & SONS, Birmingham.

Lady's Peakless Cycle Saddle.

THE NEW CYCLE COMPANY, Northfleet.

Patent Chainless and Changing Gear Bicycle.

THE CYCLE PATENTS SYNDICATE, 41, Parliament-street, S.W.

Byrne's patent Sliding Seat Tricycle.
" " Brush Chain Brake.

THE GRIFFITHS CYCLE CORPORATION, Oriel-house, Coventry.

Dunlop Bicycle fitted with all accessories.

THE NEAL CYCLE AND MOTOR COMPANY, 210, Strand, W.C.

Bayliss-Thomas "Excelsior" Lady's Bicycle.
"Unique" Cycle Lamp.
"Miller" "
Sykl American Foot Pump.
Chaix Oscillating Cycle Saddle.

THE FOWLER CYCLE MANUFACTURING CO., 102, Fore-street, E.C.

Casting, illustrating the construction of the Fowler Truss Frame for Cycles.

MARRIOTT & COOPER, Holborn-viaduct, E.C.

Standard pattern Bicycle, convertible from a Lady's to a Gentleman's Safety by unscrewing one nut.

NORTH EUROPEAN CYCLE EXPORT COMPANY, 30, Snow-hill, E.C.

The Eddystone Cycle Lamp, and other Accessories.

BRITISH ZENITH ADJUSTABLE CYCLE CO., Dashwood-house, New Broad-street.

"Elswick" Bicycle, fitted with the Zenith Adjustable Handle and Treads.

THE ALCOLITE SYNDICATE, 121, Vauxhall-road, Birmingham.

Samples of Castings, Cycle Components and Tubes made of Alcolite Metal.

Bicycle with frame made of Alcolite Metal.

DISCUSSION.

Mr. W. T. SHAW expressed his gratification at seeing these pictures representing the evolution of the cycle from its early stage. Almost the only type which had not been represented was the very first to graduate in respectability, viz., the Otto, in which there were two large wheels side by side. He recollected that the riders of that machine rather prided themselves on their respectability, and they were certainly a very select body, one reason being that it was horribly difficult to ride. As illustrating what had been said on this point he might refer to the case of a distinguished member of the bar who used to ride an Otto, but he remembered his telling him that he did not venture to tell his wife and family anything about it, but used to keep it in a mews, from whence he used to start and ride down to Lincoln's-inn. All that was now changed, and you saw bicycles issuing from the best mansions in the West-end. Although Britishers, including of course the pioneers on the other side of the Tweed, might well be proud of the enormous share they had taken in the development of the bicycle, he must say that in some respects we were a little behind our continental neighbours. Last autumn in Berlin he noticed that at the corner of the principal streets there were men in uniform with tricycles, who could be hired for the conveyance of parcels or messages. There was not anything exactly analogous to that in London as yet, but he looked forward when there would be a much larger use of cycles in these directions.

Mr. J. W. BOOTHROYD said he had listened with much interest to the paper, but there were some omissions in it. For instance, in the historical retrospect, no mention had been made of the Kangaroo as the type of machine which first dealt with the gearing of an ordinary bicycle. Again, Mr. Hillier had not referred to the hard battle which went on for some time between the bicycle and tricycle, it being thought for a long time that the latter would be the winner, and he still thought that it would have a look in. Then there was another machine in which he happened to be interested, which was entirely unnoticed; the gear ordinary or front driver. That was not knocked out yet, and did not intend to be. It was an important machine, and he maintained that had it come out earlier than it did it would have been the machine of the day, and he did not think that the present safety could compare with it on mechanical lines, or that anyone who looked at the matter with an open mind could come to any other conclusion. Mr. Hillier, as an old rider of the ordinary bicycle, and who upheld it against the safety for years, might, he thought, have said a word in favour of this type of machine, which was on similar lines, but in a more convenient form. He thought also he might have given some remarks on racing, about which he knew more, probably, than any other man in England. His own opinion was that racing had been to a large extent the curse of cycling, as of many other sports. It would have been more interesting in many ways if, instead of giving information about old antiquated machines, he had given opinions on more modern machines, and the possibility of the future, and specially with regard to the possibility of superseding chain driving. He did not think that was at all likely, but there were several machines in the market with that object, and he should like to hear Mr. Hillier's opinion on them.

Mr. J. S. DYASON said he should like to say a word on the old dandy horse. He was one of the dandies of the period referred to, and he remembered distinctly the costume he wore when riding the dandy horse sometime in the thirties; and he also remembered their going along at a very considerable speed. When the bicycle became so popular his memory went back to that period, and he had kept it fresh with regard to it. He believed there was still a career open for the dandy horse, and possibly, if some mechanician did not take it up, he should feel obliged to do so himself, and see what he could do with it. He remembered very well at that period, when dispatches used to come from France by sailing boats, and were brought by relays of boys on horses from Dover to London, some of them used to wonder why it was dandy horses were not employed for the purpose.

Sir HENRY TRUEMAN WOOD said he could not avoid making a brief reference to one portrait which had been shown on the screen—that of the late Mr. John Mayall. He did not know before that he was a cyclist, but he was very well known in that room as a great authority on microscopes, and gave two admirable courses of lectures a few years ago on that subject. There was no one who knew so much on the subject as he did, and he (Sir H. T. Wood) did not like to see his picture without referring to the fact. The history of the invention of the bicycle was a microcosm of the history of all inventions. It showed how true it was that there was really nothing new. Everything that was invented had been invented before by somebody who was either in advance of his time, and therefore found no demand for his invention, or, possibly, had not the mechanical means for putting his invention into practice. It appeared to him that the bicycle was itself really a new invention. It had not grown out of the dandy horse, for in fact, as Mr. Hillier had shown, the connection between the two could not be traced. He fancied a great reason for the popularity of the modern cycle was the extreme ease with which riding could be learnt. He remembered in 1872 learning to ride what was contemptuously called a boneshaker, and found it matter of very extreme difficulty; in fact, he never attained to any very great skill with it. But quite recently he had found that to learn to ride the modern safety was only a matter of a couple of hours. Of course the complete history of an invention of this sort could not be given in an hour, but he did not think Mr. Hillier had done sufficient justice to the old velocipede. He remembered as a boy seeing the velocipede, with all its cranks and levers and its four wheels, being ridden about the country and in the streets of London, apparently very successfully, because he remembered about 1856 seeing a man going down the dangerous hill leading from Harrow quite safely. With regard to fashion in riding, they all knew that English ladies rode extremely upright and very gracefully. Anyone who had been much in France would have noticed that the French ladies, who were certainly no less graceful than their English sisters, one and all hung over the handle bar, and rode like the British scorcher. He could think of no other reason for this than fashion.

Mr. BYRNE said he was very pleased to hear mention made of the Otto machine, which was at one time of sufficient importance to warrant a paper being read on it in that room by Mr. Boys. The Otto, of course, was a scientific machine, and it was ridden, as had been said, by only a few people, the reason being that it was very difficult to learn. The outcome of this machine had been one in which the same action could be obtained, without any difficulty or danger by ordinary riders. The machine in question, which had a sliding seat, was on view in the library.

Mr. ALLEN VICKERS said, with regard to the question of the position on a cycle, which was termed that of the scorcher, those who knew anything about safety cycling knew that it was one which was adopted quite naturally. You might in the parks see ladies and gentlemen riding in that very graceful position which ladies usually took; but any one who wanted to move, and put in some speed work, naturally dropped into the position of the scorcher. The effect of wind had a great deal to do with it, for in sitting upright you offered a much greater resistance to the wind than when bending down over the handle bar.

The CHAIRMAN, in proposing a vote of thanks to Mr. Hillier for his extremely interesting paper, said it was a historical retrospect which had shown the evolution in the means of locomotion in this country, and in all neighbouring countries. Each step in the progress had been some slight modification upon the previous ones, until at last they arrived at the very perfect machines of the present day. It was, no doubt, ungracious to find fault with Mr. Hillier for what he had left out, but he had not carried out his history to the very last development in which the rider had little or nothing to do, but supply himself with an auxiliary steam-engine or an oil-engine on which he sat, and which did his work for him. They did not yet know how far such things might be developed; cycles which might run many hundreds of miles without much assistance from the driver, might be very practical things. If Mr. Hillier had looked in the old numbers of *Punch*, he would have found a picture by John Leech, or some other artist, which described the coming time when everybody would be riding in the Row on bicycles or velocipedes, in place of horses. He was specially interested as a soldier in the description of the use that cycles had been put to in the late Matabele war. They were all aware that the British army had not at all neglected the subject of cycling, and every regiment in the service had a large number of trained men; the volunteers especially had a large cycling section. The power which cycling would give to the army was an extremely valuable one, because without having to consider forage for their horses they would be able to ride fifty miles or more where the roads were suitable and practically to outplace the cavalry, not only for a short distance, but in the long run, on account of the endurance of a man on a bicycle being much greater than that of a horse.

Mr. HILLIER, in reply, said he agreed with his friend Mr. Shaw about the Otto bicycle. He once devoted a whole winter to it, and succeeded in learning to sit upon it, but on one occasion, when racing with it against some members of the London Tricycle Centre, just after getting through Croydon, he found himself on the road, and the bicycle trying to get into an area. It was an excellent machine against the wind, but extremely tricky and very difficult to steer as then made. It had wonderful points, and, personally, he regretted it was not further developed, but the main obstacle was the difficulty in learning. When he was in Berlin, in 1892, bicycles were not allowed in the streets at all, and he believed it was only recently that the prohibition had been withdrawn. He believed there would be a tremendous development in London, and already cycles were used to a certain extent in the distribution of newspapers, and he noticed that the boys who rode them were occasionally fined for excessive speed. With regard to Mr. Boothroyd's remarks, he might say that there were many things he should have liked to show, but he had to fix some date at which to stop, and he fixed it with the idea of keeping off debateable ground, so he stopped at 1876, when the bicycle had developed. He agreed that the tricycle probably had a future before it, and that a large number of people would adopt it when they recognised its value. In the same way the front driver as now made would be certain to grow in popularity, for it suited a great many people, and he was not at all sure it would not suit him if he only rode one machine, but as he was constantly being asked by various makers to try their machines, it would not do for him to get out of the habit of steering a rear driver. He missed steering the driving wheel as was done in the old ordinary, of which he was a strong supporter, and stuck to it to the last. As regards racing he could say a great deal. Mr. Boothroyd said it had been the curse of cycling, and as regarded the advertisement of cycling to the outside public, he agreed with him there had been scandals in connection with racing, and it had got a little out of hand, but it was getting in hand again under the rules of the National Cyclist Union, but one thing he would say for it, that it was the racing man who demanded a light weight, and had forced the makers to build a light cycle, and who tested every one of the fittings, which made it possible to build a cycle to-day to run on the road weighing 25 lbs. or less. The ordinary road rider would not have risked his life and limb in such an experiment. If you went carefully through the cycles as they were developed year after year, you generally found that the roadster bicycle of to-day with one or two little additions was the racing bicycle of the year before. There were some racing men not up to a very high standard, but there were others who brought a great deal of intelligence to bear, and made very valuable suggestions. He had one man in mind in particular to whom was due an immense development on modern cycling, and that was Mr. Fred Cooper. He knew something of the relations between him and Mr. Humber, and he insisted on the weight being reduced. With regard to the dandy horse, he had just been informed by Mr. Boothroyd that an up-to-date dandy horse was being built, with all the latest improvements, without pedals. With regard to the scorching position, one must not criticise a racing position from a road point of view; a man swimming or sprinting took the attitude suitable to the exertions he had to undergo. No doubt leaning forward presented as little surface as possible to the wind, and that was the correct position for a racing man. The evil was that a lot of youngsters went to see cycle races, and immediately went home, took their roadster bicycle, put the handles as low down and the saddle as far back as possible, and put themselves in what they imagined was the racing man's attitude to ride on the road. It was not, however, really the attitude of the racing man who always kept his chest well expanded, and was able to breathe freely, it was the imitation scorcher's attitude that was dangerous, and people should be careful, especially with children, to take care of two points—that the handles were high enough, and the saddle far enough forward. Even racing men of late years had come forward again. There was a time when everybody's idea seemed to be to get as far back as possible, but they had now come forward to a more reasonable position. With regard to the pictures in *Punch*, he had felt inclined to reproduce some of them; but on looking through a number of volumes he found that caricatures with cycles of various kinds, including hobby horses, were very numerous, extending over many years, and as most of them were of a political nature, he concluded not to introduce them. It had recently been stated that Mr. Gladstone had learned to ride a bicycle, but he thought if he looked through the volume of *Punch* he would find himself represented there many times as a cyclist, on one occasion in particular, about the Budget time, with an expression of the hope that he would be able "to keep his balance." The cycle would, no doubt, have a great future in war. It was largely used on the continent and also in our own army. He was himself on the War Office Committee for volunteer cycling, and when it first started he met with a large number of inventors, who seemed to think the bicycle would supersede cavalry altogether. That, of course, was an absurdity. The whole question lay in using the bicycle intelligently in connection with other forces. He heard it suggested at a lecture at the Royal Artillery Institution at Woolwich, that sharpshooters on bicycles should be sent out over good roads in front of the army to hold certain positions, because for the last twenty years no battle in Europe had been fought off a line of road. It was thought by some that if a bicycle were built rather heavier and lower geared than the fine machines used for the best roads, a soldier could go anywhere and do anything with it. One of the experiments at Aldershot was to ride over fields and through woods, but Major Fox was not altogether satisfied with the way they went across country. They suggested to Major Fox that he should pick out a spot, 50 miles distant, to which the cyclists should make their way as best they could, report themselves and return, and that he should also set a number of cavalry to do the same thing, but he did not accept the suggestion. Cycles were mainly used at present in the Army for message carrying, as they were silent and not very conspicuous, and they had proved very useful for that purpose.

Notes on Books.

SANITARY HOUSE DRAINAGE. By T. E. Coleman.
London: E. and F. N. Spon. 1896.

The principles on which domestic sanitation should be conducted are now tolerably well known, not only to experts but to the public generally. Mr. Coleman gives a very clear and complete account of those principles in their application to the sanitation of town houses. After a general account of the principal objects to be held in view, he proceeds to describe in detail the various appliances and systems employed. He commences with the construction of drains, including those for carrying off rain water as well as sewage; their ventilation; form, materials, and joints of drain pipes; methods of laying drains; inspection and intercepting chambers; ventilation; traps and gullies. He then proceeds to the internal fittings—water-closets, baths, sinks, lavatories, &c. In conclusion, he describes the usual method of testing drains, both old and new. The treatise is very fully illustrated, and gives a very complete account of the whole subject.

A Text-Book of the History of Sculpture. By Allan Marquand and Arthur L. Frothingham. New York: Longmans, Green and Co.

This is one of a series of College Histories of Art and contains an account of sculpture from the early times of art to the present day. The first thirteen chapters deal with Egyptian, Babylonian, Assyrian, Persian, Hittite, Phœnician and Cypriote, Greek, Italic and Etruscan and Roman sculpture, early Christian and Byzantine sculpture, mediæval sculpture in Italy, France, and Germany. Renaissance sculpture in Italy, France, Germany, the Netherlands, Spain, and England are dealt with in subsequent chapters, and the remainder of the book is devoted to modern sculpture. It will be seen in this enumeration that no mention is made of mediæval sculpture in England, although fine examples of sculpture are to be found in English cathedrals and churches as in those of France, Germany, and Italy. The name of Roubiliac, one of the most realistic sculptors that ever lived, does not appear anywhere in the pages of this book. The volume is fully and well illustrated.

Beauty and Art. By Aldoun Heaton. London: W. Heinemann.

The author deals with his subject in a series of chapters devoted to "Taste," "Beauty in Form and Colour," "Decoration of the House," "Fabrics," and "Furniture and Decoration of the Eighteenth Century." He considers that the fact that evolution is a secret and keynote of art, no less than of nature, has been too much overlooked, and that there is evidence among modern artists and designers of a definite intention to introduce entire novelty, not only ignoring the design of the past, but as far as may be, defying it. He holds that there is a standard of beauty, and that it is not, as is supposed by many, merely a matter of opinion. The great point is to learn to see, and the author believes that no one quite sees a landscape until he has learnt to draw one, or to see the beauty of flowers until he has tried to represent them. With regard to colour, the secret of nature is that what appears to the careless observer is a blaze of a certain tint is in reality a mass of subtle gradations. Hence when one gathers flowers we find that they harmonise together, and we have not the fear that is so common in the mixing of colours of fabrics in the drawing-room. The case is the same with respect to a fine old Persian carpet, "which will probably contain blues and greens, reds and yellows, orange, quiet purples and whites of various degrees," and yet it will probably look well in any room in which it may be thrown down "with an entire disregard of what may be already there." In the chapters on the "Decoration of the Home," and on "Furniture and Decoration," Mr. Heaton refers to the work of the great decorators of the eighteenth century, and describes what was done by such men as the brothers Adam, Chippendale, Sheraton, Heppelwhite, and others. In alluding to a work, published in 1744, containing the designs of Inigo Jones and William Kent, the author does less than justice to the former great architect. He writes:—"There is an air of the competent architect about them, as one might expect, and for halls of large houses or public buildings they might well be useful. How he came to ally himself with Kent it is not easy to understand, Kent's part of the work being weak and worthless." Jones died in 1652 and Kent was born in 1684, so that they could not very well collaborate.

General Notes.

Spanish Iron Production.—The production of iron ore in Spain for the year 1896 was, according to the *Revista Minera*, 6,808,000 metric tons, an increase of 1,293,671 tons, or 23·5 per cent. more than 1895. The exports were 6,253,473 tons, a gain of 1,005,281 tons, or 19·2 per cent. The production of pig iron in Spain was 246,326 tons in 1896, of which 23,805 tons were exported. The production of steel ingots was 104,577 tons, 62,511 tons being made by the Bessemer and 42,066 by the open hearth process. The total production of wrought iron and steel in bars, plates, and other finished forms was 137,809 tons. There were seven steel and iron works in operation during 1896.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

April 7.—"Dairy Produce and Milk Supply." By M. J. Dunstan, M.A., F.R.S.E. The Right Hon. Lord Belper will preside.

April 28.—"Asbestos." By Robert H. Jones.

May 5.—"The Railway to India." By C. E. D. Black.

May 12.—"Motor Traffic: Technical Considerations." By Sir David Salomons, Bart.

May 19.—"London Water Supply." By Percy F. Frankland, Ph.D., F.R.S.

MAY 26.—"Silver and Prices: the Economic drain of Debtor Nations." By MORETON FREWEN, B.A.

INDIAN SECTION.

MAY 6, at 4.30 p.m.—"Kafiristan: its Manners and Customs." By SIR GEORGE SCOTT ROBERTSON, K.C.S.I. (late British Agent at Chitral). FIELD-MARSHAL LORD ROBERTS, V.C., G.C.B., G.C.S.I., G.C.I.E., will preside.

MAY 20, at 4.30 p.m.—"India and its Commerce." By SIR JAMES LYLE MACKAY, K.C.I.E. (late President of the Bengal Chamber of Commerce).

FOREIGN AND COLONIAL SECTION.

Tuesday Evenings, at Eight o'clock:—

APRIL 6.—"Recent Travels in Rhodesia and British Bechuanaland." By C. E. FRIPP. AUGUSTUS HELDER, M.P., will preside.

MAY 4.—"The Arctic and Antartic." By AUBYN TREVOR-BATTYE.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock:—

APRIL 27.—"Delft Ware." By Dr. J. W. L. GLAISHER, F.R.S.

MAY 11.—"A Half Century of Line Engraving, 1780-1830." By GEORGE CLULOW.

CANTOR LECTURES.

Monday Evenings, at half-past 4 o'clock:—

PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., "Alloys." Four Lectures.

LECTURE IV.—APRIL 5.—Advances in our knowledge of alloys since the last course of Cantor Lectures "on Alloys" was delivered, in 1893.

LEWIS FOREMAN DAY, "Design in Lettering." Four Lectures.

May 3, 10, 17, 24.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 5...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Cantor Lectures.) Prof. W. Chandler Roberts-Austen, "Alloys." (Lecture IV.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. Kinnear, "The Culture of Flax and Hemp in England, and their After Treatment."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Prof. T. Roger Smith, "Sanitary Building Construction."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Mr. Oscar Guttmann, "The Chemical Stability of Nitro-compound Explosives."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. Walter Simms, "London—an Appreciation."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Bishop of Ballarat, "Australian Aboriginal Art."

East India Association, Town Hall, Westminster, S.W., 4 p.m. Mr. Robert Sewell, "India before the English"

TUESDAY, APRIL 6...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. C. E. Fripp, "Recent Travels in Rhodesia and British Bechuanaland."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. D. Waller, "Animal Electricity." (Lecture XII.)

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Mr. Henry W. Ravenshaw's Paper, "Electric Lifts and Cranes." 2. Messrs. David Hay and Maurice Fitzmaurice, "The Blackwall Tunnel."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

WEDNESDAY, APRIL 7...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. Dunstan, "Dairy Produce and Milk Supply."

Geological, Burlington-house, W., 8 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Law Bros, "Pictures from Sicily."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, APRIL 8...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. J. Wright Clark, "Details of Plumbers' Work."

Society for the Encouragement of Fine Arts, 9 Conduit-street, W., 8 p.m. Mr. Seymour Lucas, "Making a Picture."

Royal Institution, Albemarle-street, W., 3 p.m Prof. W. Boyd Dawkins, "The Relation o Geology to History." (Lecture III.—"Romar Britain.")

Electrical Engineers, 25, Great George-street, S.W. 8 p.m. Mr. H. A. Baylor, "Recent Development in Electric Traction Appliances."

Numismatic, 22, Albemarle-street, W., 7 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m.

Camera Club, Charing-cross-road, W.C., 8¼ p.m Messrs. Stroh and Cole, "The Phonograph."

FRIDAY, APRIL 9...Royal Institution, Albemarle-street, W. 8 p.m. Weekly Meeting. 9 p.m. Lord Rayleigh "The Limits of Audition."

Civil Engineers, 25, Great George-street, S.W. 8 p.m. (Students' Meeting.) Mr. Harold Berridge "Poole Harbour."

Astronomical, Burlington-house, 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington house, W., 5 p.m. 1. Messrs. T. A. Garrett an W. Lucas, "A Nickel Strip Telephone." 2. M W. A. Price, "Alternating Currents in Concentri Conductors." 3. Mr. W. B. Morton, "The Effe of Capacity on Stationary Electrical Waves i Wires."

SATURDAY, APRIL 10...Botanic, Inner Circle, Regent's-pa N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p. Lord Rayleigh, "Electricity and Electrical Vibr tions." (Lecture VI.)

Journal of the Society of Arts.

No. 2,316. Vol. XLV.

FRIDAY, APRIL 9, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday afternoon, 5th inst., Prof. W. Chandler Roberts-Austen, C.B., F.R.S., delivered the fourth and last lecture of his course on "Alloys."

On the motion of the Chairman (Sir Charles M. Kennedy, K.C.M.G., C.B.), a cordial vote of thanks to the lecturer was passed.

The lectures will be printed in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday, April 1st; Field-Marshal Sir Donald Stewart, G.C.B., in the chair. The paper read was "A Visit to Russian Central Asia," by F. O'Dwyer, I.C.S.

The paper and report of the discussion will be printed in the next number of the *Journal*.

JOURNAL ADVERTISEMENTS.

From the present date all arrangements connected with the advertisements in the Society of Arts *Journal* will be in the hands of Messrs. Street Brothers, 164, Piccadily, W. All communications, therefore, referring to advertisements should be addressed in future to Messrs. Street.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The fourth meeting of the Congrès International de l'Enseignement Technique will be held this year in London, commencing on the 15th of June next, at the invitation of the Society of Arts, and of the Worshipful Companies of Drapers, Fishmongers, Goldsmiths, Merchant Taylors, and Clothworkers.

The Congress will be opened at 11 o'clock, on the 15th of June, by an address from the President, the Duke of Devonshire, K.G.

The subjects for discussion at the Congress will include:—

Technical Education:—

1. Advanced Instruction. Polytechnics, Universities, Colleges.
2. Secondary Instruction. Higher Technical Schools; Secondary and Intermediate Schools; Evening Schools.

Commercial Education:—

1. Advanced Instruction. Colleges; High Schools and Institute of Commerce.
2. Secondary Instruction. Commercial Schools; High Schools; Classes for Adults.

It is not proposed to deal with elementary Technical or Commercial Education. The education of both sexes will be included. Further information will be issued at a later date.

The Executive Committee will be glad to receive offers of papers coming within the scope of the subject as above defined. The papers must be in the hands of the Secretary not later than the 29th May.

The papers will be printed and distributed at the meetings. They may be in French, German, or English, and speakers may make use of any of these languages.

All communications relating to the business of the Congress should be addressed to the Secretary, Society of Arts, John-street, Adelphi, London, W.C.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, March 30, 1897; Sir George Birdwood, K.C.I.E., C.S.I., in the chair.

The Chairman said it was not necessary to introduce the reader of the paper, Mr. W. R. Lethaby, to any audience interested in the encouragement and improvement of the applied arts of this country. Mr. Lethaby was the well-known author of a work entitled "Architecture, Mysticism and Myth," published by Percival in 1892, and of another, entitled "Leadwork," published by Macmillan in 1893, and already recognised as a classic on its subject. He was known to their Applied Art Section also as the author of a paper on "Cast Iron," read before them in 1890. He would, therefore, at once call upon Mr.

Lethaby to read the paper he had prepared for the present evening.

The paper read was—

LEAD WORK.

BY W. R. LETHABY.

My having been invited to read a paper on lead working is, I suppose, a consequence of my having some years ago made a little book on the subject, which I have to mention because the notes which follow will be very much in the nature of an appendix to it. A kind and very friendly reviewer remarked that the essay in question had apparently been put together from material in my hands at the time of writing. This was penetratingly true, and I confess I look on the present as an opportunity of stringing together the few further facts (not for the most part purposely sought for) which have come in my way, or have been noted in my reading.

The account of ancient lead working could be much amplified, but I only propose to refer to the Roman coffins of this material to enquire how far they were of English lead and made in this country. These Roman coffins, I believe, fall into two main groups—the first and earliest (I think) found in south-east England and north-west France, and the other in Syria. The chief characteristic of the English examples seemed to be the use of the escallop shell in their decoration.

In an article in volume ix. of the Kent Archæological Society, several Roman coffins found at Bexhill are described. One of these was ornamented with little Medusa heads and pairs of lions *affronté*. The absence of the escallop shell is remarked upon, and I cannot see anything which divides these off from the northern French examples, so that I am now inclined to look on all these as of English make.

I pointed out a small square vessel in the Museum at Lewes as being of Saxon workmanship, but thought that it might be a font. I now find that from its resemblance to another box found at Folkestone that it is more probably a relic casket. That found at Folkestone was ornamented with a network of lines formed of little beads. A portion of another lead relic casket has been found at Lyminge. A book cover in lead, with an inscription from Ælfric's Homiles in runes, is another pretty example of Saxon workmanship.

As I have suggested was the case in the Roman age, so also in the early middle ages the art of working in lead was an especially English industry. When about 1090, the roofs of Coutances cathedral in Normandy had been destroyed by lightning, Geoffrey the bishop sent to England and called Brisenetus the plumber to make afresh the leadwork of the roofs and tower, and to replace a gilt weathercock. ("Memoires de la Société des Antiquaires de la Normandie," 1824, p. 155.)

There are in England about 30 fonts, or rather font basins, of lead; they are mostly of cylindrical shape, are beautifully ornamented, and in the main belong to the end of the 12th and the 13th centuries. The question of French or English crops up again with regard to the fonts. The beautiful font at Brookland, in Romney Marsh is, I have come to the conclusion, of French work, as it is in many respects identical with a font at St. Evroult, between Le Mans and Falaise.

In regard to the English examples, I have been informed that the font at Clewer, which is usually given in the lists of lead fonts, is not of that material. That at Wansford in Northamptonshire, is also said to be of stone. According to "The Antiquary" there is a font at Oxenhall, Gloucestershire. In the Gloucester Museum there is, I am told, a lead font, and also a small vessel ornamented with reliefs of the instruments of the Passion. The font at Ashover, in Derbyshire (described sometimes—by myself amongst the number—as of stone with lead figures) has the basin entirely of lead, it is surrounded by 20 figures of apostles. All the figures were repetitions of two models, such was the economy of means by which these old works of art were produced.

De Caumont has described several French fonts of lead of the 12th century. In the Abécédaire he gives some figures of the font of St. Evroult de Montford (Orne). Between four figures (which although repeats of the same model stand for the four Evangelists) are placed a double row of little arcaded panels occupied by the labours of the months, each being surmounted by one of the signs of the Zodiac. They are not placed in order, and are repeated three or even four times. "The matrices which made the mould each carried two months." De Caumont remarks on the panels being evidently a set of stock patterns to be used for different purposes, and notices the resemblance to the Brookland font which must have been made in the same shop.

In the 14th century and later, lead fonts continued to be made in France. De Caumont illustrates a fine octagonal example at Mesnil-Mauger. In the Museum at Rouen, one of three examples is as late as Francis I.; another is of 15th century work with a long inscription in three lines running all round it; the third is of the 12th century. In the same museum is a beautiful abbey lavatory of lead similar to if not the same as that illustrated by Viollet le Duc, as of bronze; also some fine finials.

The lead font of Maintz is probably the largest and most carefully wrought lead font existing; it is in the form of a melon-shaped cup, ornamented with figure subjects of Christ, the Virgin, St. Martin, and the Apostles. It was cast 1328, and must be five or six feet in diameter. This is a cathedral font; all the others belong to small village churches.

Methods of water supply were much more advanced in the middle ages than we are likely to suppose. "Water leaders" seem to have been separate from plumbers, as we find both mentioned amongst the York crafts who took part in the mistery plays. A water leader was at work at the Palace of Westminster early in the relgn of Henry III., and a conduit (doubtless the well-known canopied fountain in New Palace Yard) is mentioned in connection with the work. These fountains or conduits are the typical feature of Mediæval water supply. Four such fountains are shown in the elaborate plans for laying on the water to Christ Church, Canterbury, shown in the 12th century plan. Here basins in one or two stages stand under lead-covered roofs supported on pillars just like those which to-day may be found in the courts of the Greek monasteries of Mount Athos. Such central fountains in the courts, with here and there a draw off to a lavatory or kitchen, must have been the general method of distributing water in monasteries and the great houses. The water was first collected into a basin or reservoir, and then carried to one of these conduits in lead pipes. The streets of London were extensively supplied with such fountains at the end of the 13th century, and notices of the several conduits may be found in the pages of Stow. The canopied fountain in Trinity Quad, Cambridge, follows this traditional form, and, probably, now best represents some of these old conduits: others were solid erections.

Some interesting facts in regard to the water-supply of Hampton Court may be found in Law's history of the Palace. At Nonsuch a large water-tower formed part of the palace; contained an immense cistern of lead, from which pipes supplied the whole house with water. In the gardens were several fountains, but these were principally of marble.

At Windsor, in the middle of the 16th century, but before the Gothic tradition had entirely lapsed, a great fountain, mostly of lead, was erected in 1555, when water was conveyed to the Castle from Blackmore-park, five miles away. The accounts of this work exist, from which we see that John Puncherdon, "Plummer," had charge of the work. A pipe was brought to the centre of the great upper court "and there the water plenteously did rise 13 foot high." A reservoir was formed from which water was distributed to every part of the building, and a fountain "of curious workmanship" was made in the court. It consisted of a great basin with a canopy "gorgeously decorated with heraldic ornaments, coloured and gilt." In the centre a great Tudor dragon spouted the water into the basin.

In the accounts we have such items as these:—

> Plumbers working the cistern and laying pipes. Carpenters making the great mould in the plumbry. Carvers carving the carthowages (cartouches), and scouchions for the fountain in wood and stone. Founders casting patterns in metal to garnish the cistern and top of the fountain. Carvers carving scouchions in wainscott to make patterns for the moulds of the scouchions, and badges to garnish the cistern and top of the fountain. Plumbers soldering arms about the fountain, and leading the lavatory about it. For carving six Beasts Royal, viz., an eagle, 6 ft. long; a lion, 5 ft. 11 in.; the antelope, 5 ft. 6 in.; greyhound, 5 ft. 5 in.; the griffith, 5ft. 4in.; the dragon with his base, 13 ft. 4 in. (The Royal beasts were the Tudor badges.) To John Puncherdon, sergeant plumber, and Henry Deacon for finishing the garnishing of the fountain in great as was agreed between the Lord Treasurer and them, £60. [For workmanship only.] To Nicholas Lyzard, sergeant painter, for painting and gilding the great vane with the king's and queen's arms, with a great crown. Also for painting, priming, stopping, gilding, and varnishing a great lion and eagle holding up the said vane, first primed with soden oil, secondly, with red lead and soden oil, then stopped with oils and red lead, then primed twice and wrought three times in colours, and so gilt with fine gold in oil, and so varnished. Also for painting in the same way the beasts, arms, freezes and cornices, £57."

Lead cisterns in the kitchens of the palace at Westminster are mentioned as early as 1250. I know of none of Gothic workmanship still in existence. One of the finest of the later ones is at Nottingham Castle; it is ornamented with coats of arms. In the court off the south side of the cloister at Lincoln Cathedral there is a nicely decorated circular tub receiving the water from a down pipe, probably 17th century work.

Old lead was cast for use on the spot by the plumbers. Accounts run "for founding and laying" so many fothers of lead. The price for this in London in the 13th century for workmanship only (casting and laying) was 5s. a fother.

There are several interesting points about the laying of lead on plain roofs. At Exeter, for instance, the sheets do not run up the slope parallel to the gable ends, but incline to them at an angle. At Beauvais the sheets are laid horizontally in sheets about 10 feet long, the rolls being that distance apart, and intermediate support being given by clips. The early lead roofs I have examined have been laid on oak battens very thin and light, say five inches wide by half an inch, with a space of two inches or so between them. The rolls were always formed without wooden cores. These roofs of cathedrals were sometimes decorated by painted patterns. At Troyes, I am told, the roof was diapered over with golden flames.

How general and gorgeous was this decoration of lead work in France may be judged from the fact that Rabelais makes the slated roof of the Abbey of Thelema to have a broad band of lead at the ridge with little gilt figures and animals; the down pipes being painted in diagonal stripes of gold and azure. Tinning was the favourite method of surface decoration for lead in France. There are not many existing instances of this work in England. At Hatfield some of the pipeheads have patterns of tinning, which, the plumber there told me, showed evidence in some cases of being applied through a cut pattern like a stencil. Tinning also occurs, I believe, on the Knole pipeheads. Pierced work is best cut with mallet and chisels.

The *flèches* or wood lead-covered spires which so often surmounted the roofs of French cathedrals, were usually so splendid with gilding and bright colours, that they must have looked like large pieces of enamelled goldsmith's work. On the east end of the roof of Reims stands the Angel *flèche* (remade about 1500); it is a lead-covered turret, about 60 feet high. Round its supports stand eight images of lead, all gilt, and traces of painting and gilding are visible all over the leadwork. The rolls were gilt, and the surfaces cheveroned in red and another colour. On its apex stands the angel which gives the *flèche* its name; it is of copper, and turns to the wind. On the apex of the south transept gable is an ancient figure of a Sagittarius of gilt lead, which seems to discharge an arrow towards the court of the Archbishop's palace, where a bronze fawn used to mark the point of its aim.

In the East lead-covered domes are frequently found entirely gilded all over. Travellers in Persia frequently mention the gilded domes at Koum and Ispahan. Early travellers' accounts make it clear that the dome over the Sacred Rock at Jerusalem was gilt, but the material was here, I believe, copper.

Tavernier writes, that at Delhi there was a mosque, "the dome of which was entirely covered with lead, and so thoroughly well gilt that some indeed believe the whole is of massive gold." In Russia the domes of the churches all over the country are gilt or brightly painted.

It appears from a paper printed by the late Dr. Sparrow Simpson that when it was proposed to cover the dome of St. Paul's with copper, it was argued that copper "would soon be black and look ugly, so that the people would by no means be pleased with it." It was urged in reply that the "looks" of lead should not be set against the "duration" of copper, which also would be 600 tons lighter; lead, however, was chosen. John Roberts (plumber) estimated for lead £2,500, Davis and Co. (coppersmiths) for copper £3,050. It is interesting to note that copper even then went black, as it still does to our frequent disappointment. This blackness appears sometimes only an intermediate stage to the turning to the desired green, but sometimes I fancy the green never comes, at least in London.

The quantity of lead work made use of in the middle ages in England was enormous; there seems to have been nothing like lead. I have before spoken of the typical London spire as being covered with lead. We find in inventories of St. Paul's how much it was used for small objects, like holy water basins, and even candlesticks. At the end of the Gothic period it was also greatly used in domestic and semi-domestic buildings, especially in London. Under Bread-street Ward, Stow describes "the most beautiful frame of fair houses and shops, that be within the walls of London, or elsewhere in England, commonly called Goldsmith's-row . . . built by Thomas Wood, goldsmith, one of the sheriffs of London, in

1491. It containeth ten fair dwelling-houses and fourteen shops built four stories high; beautified towards the street with the goldsmiths' arms and the likeness of woodmen (in memory of his name) riding on monstrous beasts, all of which are richly painted over and gilt. The said front was again new painted and gilt over in the year 1594." This gaily illuminated lead-work was especially made use of in the fantastic tabernacle roofs, which surmounted the octagonal turrets and bays so much in vogue in the Tudor period. We have only one or two little turret roofs left at Hampton Court to represent what were often tall and ornate structures painted and gilt like the houses just described or the great fountain at Windsor. From the prints of Richmond, Greenwich, Hampton Court, and Nonsuch Palaces, we are given some idea of the fantastic beauty of this work, if we paint and gild it in our imaginations. The descriptions of Nonsuch speak of it as "battlemented," with frames of wood covered with lead, and supported with strong bars of iron, "which battlements are a great grace and special ornament to the building."

Numerous big houses in London would follow the same fashion, and almost every hall had one or two of those turret louvres of which that on Barnard's-inn Hall is the best existing specimen. In 1481, William Hariot, draper gave £40 to the making of the two "louvres" of the Guildhall. Stow also tells us that Sir Thomas Lovell, who built the gateway of Lincoln's-inn, "caused the Lacy's arms to be cast and wrought in lead on the louvre of the hall."

The spire of old St. Paul's was burnt, as is well known, in the reign of Elizabeth, a hundred years before the great fire. Dugdale gives a view of the cathedral, showing a tall Renaissance steeple, which he appears to think was the original, for after describing that he adds, "a perfect representation of all which as it then stood I have here exhibited." The meaning of the Renaissance spire seems to be explained by a large drawing now in the possession of the Society of Antiquaries, when taken together with what Stow relates. It appears that the old spire was burnt in June, 1561. Stow says:—"After this mischance the queen directed letters to the mayor willing him to take order for the speedy repairing of the same (the roofs and spire). The work was put in hand the same year, and the roofs completed before 1566. Concerning the steeple (continues Stow), divers models were devised and made, but little else was done, through whose default God knoweth. It was said that the money appointed for the new building of the steeple was collected."

The drawing at the Antiquaries is a large and very carefully detailed design, lettered—"New spire for St. Paul's in place of that destroyed by lightning." On the design of the structure itself appears the date 1562. The engraving in Dugdale is a most careful rendering of this design put into perspective, and must represent one of the models prepared for the spire after the fire; the Antiquaries' drawing either being the original design, or a copy of the same model.

I before mentioned the isolated belfry at Salisbury; this was an extremely beautiful erection contemporary with the cathedral, and standing to the north of it where its position is yet marked on the grass in dry summers. From some prints the great beauty of this structure may be judged: a broad stone tower was surmounted by the belfry proper of wood covered with lead.

At Worcester there was a similar isolated belfry called the clochium or leaden steeple, This also is said to have been built in the time of Henry III. The tower was octagonal, 61 feet in diameter, and only 60 feet high. It was surmounted by a wooden spire 150 feet high, which was thus 2½ times as tall as the tower it stood on—an abnormal proportion to our eyes. "Being considered of no use it was taken down in 1647."

At Westminster Abbey another isolated belfry was built about 1245-50. This stood in the Little Sanctuary. Stow describes it as "a strong clochiard of stone and timber covered with lead," containing the great bells rung at coronations, triumphs, and funerals. Other lead spires in London besides those I have before mentioned, were St. Michael's, Cornhill, St. Dunstan's in the East, and St. Lawrence Pountney.

The corner pinnacles of the great early 14th century leaden spires at Lincoln still exist. Seen from the tops of the towers, they appear large works in themselves. When at Lincoln about a year ago I was grieved to find that most of the unique lead parapet to the choir, of 13th century work, had been renewed. In the stonemason's yard I found and measured a portion of the oak planks over which the lead had been dressed; the thickness was 4 inches, the height 1 ft. 10½ inches, made up of two planks dowelled together. The six-foil figures were

1 ft. 6 in. diameter, and roughly cut into the planks.

Of smaller gutters and pipeheads there is said to be piece of late Gothic gutter in Tennant-street, Derby; and a very pretty piece of Elizabethan gutter with a pipehead is in a back street at Winchester.

A portion of the 14th century ridge of Exeter Cathedral may be seen in a case on the top floor of the Architectural Museum. Old prints of Holyrood show a beautiful ridge which used to surmount the hall or chapel. At intervals large crowned roses and thistles (I think, for I speak from memory) stood up along the sky-line; these, of course, were painted and gilded.

A very pretty old *flèche* still surmounts King's College Chapel, Old Aberdeen, decorated with patterns cast with the sheets, such as shields bearing pots of lilies, the initials C.R., crowns, thistles, &c. A cast statue surmounting a town pump, and other lead work in the city, have been brought to my notice by Mr. Watt.

The account of the Windsor fountain gives earlier instances of the casting of large figures in lead than any I knew before. I could give a considerable list of late garden figures and vases, but I wish merely to refer to one or two. A pair have lately been added to the South Kensington Museum from a garden near Shrewsbury. At Powis Castle, in Wales, there is a large Pegasus which formed a fountain, and at Naworth Castle, I am told, there are several figures. I know of one in a London shop, and there is said to be another down an area. One of the latest instances of the use of lead for statues known to me, is a figure of Napoleon I. set up on the Arc de Triomphe in 1809.

One of the most curious uses of the material has been brought to my notice by a friend travelling in Germany. The floor of a room in a castle had lead inlaid in the wood to form a pattern. It is described to me as like a central sun, with waving rays filling up the rest of the space, the work probably of the 17th century.

Of inscriptions, the prettiest I have found noticed are two round plates about 12 in. diameter, found engraved with the epitaphs of two 12th century bishops at Mont St. Michel. These were engraved with patterns and inscriptions, and were placed in the coffins beneath the heads of the bishops, like nimbuses. In one of the cases in the chapter-house at Westminster is a plaster duplicate of a cast lead inscription in beautiful "black letter," found on the coffin of Henry VII. The extremely minute relief on the Wolfe monument at the Abbey, is, by Cunningham, said to be of "lead bronzed over," the work of Capizzoldi.

Over the entrance to the Master's Court in the Charterhouse is a lead panel having the arms of Sutton, and dated 1611.

It is almost useless trying to put interesting workmanship into dull and poor materials. It must be allowed that modern sheet lead has a poor, mean, crushed mill-board look, and its wretched colour puts it quite out of court as anything but a mere makeshift. Cast lead, on the contrary, has a beautiful surface, it is cast with the greatest ease with the most simple of appliances, and does not blacken by exposure to the air as milled lead does. I had been told that the beautiful whiteness of old lead work was owing to the silver left in the old metal; but this is not the case, or only in a small degree. Modern cast lead does not blacken like the milled sheets. For gutters and flats cast lead alone should be used, if for practical reasons alone. For purposes like hot-water sinks (for which milled lead is almost useless) cast lead will be found to answer. It is said that milled lead was introduced into England about 1670. The plumbers of the time opposed its use, and said it could not be durable. The Milling Company replied by offering to keep milled lead of 7-lbs. a foot in repair for 40 years for an insurance of ¼ per cent. That, to me, seems saying very little for the material; it would have said little in the middle ages at least, then the 40-years' view of things had not been invented.

When some months since some practical classes were instituted by the Technical Education Board of the County Council in Regent-street, I was allowed to get my friend Mr. Troup, who has devoted much personal practice to working in lead, to supervise a class for experimenting in casting and ornamenting lead. A small casting table was set up, and I must confess that I there saw the casting of lead for the first time. The same course has also demonstrated the extreme ease with which this beautiful material is bossed up and otherwise manipulated. I find to-day that practical plumbers will explain that the great objection to cast lead is the comparative difficulty with which it can be beaten up. If they would only try they would find how mistaken this view is.

DISCUSSION.

The CHAIRMAN said that he had never listened to any paper read before the Society of Arts with greater pleasure than to the one with which Mr. Lethaby had favoured them that evening. Mr. Lethaby had apologised for the haste with which he had prepared the paper, and he had not even written it out at length, but had read it from rough notes. But he had no need to make any excuses for himself. He had his subject "by heart," in the best sense of the phrase, and had treated it with the ease and lucidity that came of perfected knowledge, and with the stimulating enthusiasm and charm of the master who loved his art before his craft. He (the Chairman) was particularly gratified with the paper, as for years past, in fact from the first institution of the Applied Art Section, he had desired to have the subject of ornamental lead work dealt with before them by Mr. Lethaby. It had been suggested to him by what he had seen of old English ornamental leadwork, when passing, some years ago, through Derbyshire, the chief source of lead, as Cornwall is of tin, in England,—"the classic (western) land of lead and tin." Mr. Lethaby's paper had more than fulfilled his expectations; and he hoped it would be incorporated in the next edition of Mr. Lethaby's book on "Leadwork." The paper practically exhausted the list of known objects of artistic lead work in England; but Mr. Lethaby, among the minor examples of the finest English lead work, had overlooked two remarkably interesting small statues, recently acquired by the South Kensington Museum. They were figures of a boy and a girl, from the garden of an old house in Shrewsbury. Nothing is known of their history, but they are supposed, Mr. C. Purdon Clarke tells me, to be the work of some English artist of the end of the 17th, or beginning of the 18th century. Louis François Roubilliac, who came to London in 1720, and died here in 1762, and was patronised by Sir Edward Walpole (second son of Sir Robert Walpole), and other English noblemen, undoubtedly promoted the fashion in this country of decorating gardens with statues cast in lead; but these figures from Worcester are typically English, and are exactly in the style of the little figures in biscuit porcelain of the middle of the last century; and they are an invaluable addition to the collection of English 17th and 18th century art work now at last being formed at the South Kensington Museum. I say "at last," for as Mr. Chamberlain said the other day that there were Englishmen who allowed foreigners only to be patriots, so the authorities at South Kensington had, until late years, apparently held that only foreigners could be artists, and one found everything illustrated in the National Art Museum but British art. Another example of old English lead work, as used in architecture, overlooked by Mr. Lethaby in his paper, although referred to in his book, was the "great and high clochiard, or bell house," terminating in a spire "covered with lead, with the image of St. Paul at the top," formerly attached to St. Paul's School. The spire was pulled down by Sir Thomas Partridge; and Stow adds, "The man was afterwards hanged on Tower Hill." It is always a pleasure to come upon any coincidence that seems to justify a belief in the moral superintendence of the world, but one may doubt whether we really have an exemplification of it in this instance, or surely, in all consistency, something exhilarating should have happened by this time to the dean and chapter of Peterborough. He (the Chairman) had long been familiar with the effective form that could be given to cast-lead, from common toys and household utensils to statuary and such features of architecture as turrets, and belfrys, and spires, and with the effective way in which it could be ornamented in the case of pipe heads and cisterns, and fonts and shrines, with tin solder; but he had never realised before that night that lead work had been executed on the colossal architectural scale, and with the profusion of extended gilding and enamelled colouring, described by Mr. Lethaby—its high illuminated line along cathedral roofs, and running up their skiey spires, rivalling the rainbow,—

"With listed colours gay, Or, Azure, Gules,"—

in its enchanting splendours of gorgeous iridiscence. Mr. Lethaby had referred to the gilding of the leaden covering of a mosque at Delhi. He (the Chairman) had never before heard of this, and did not understand it, probably through sheer ignorance on the point. But although lead ores were to be found in the transition rocks of India, and lead mines would appear to have been in former ages worked in Bengal, and Rajputana, and the Punjab, and also in Southern India, none of them had been kept open, and metallic lead was now seen in India only in the bazaars, as an import from abroad, and chiefly for use in the ritualistic prescriptions for compounding the images of certain of the gods. It was also imported, and more frequently seen, in the form of powdered galena, sold as a substitute for powdered sulphuret of antimony (*surma* or *kohl* = "coal"), used by the women throughout the East, it is said by Western writers, for blackening, but really for cooling the eyelids, although its effect is to heighten the brilliancy of the eye.[*] He (the

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[*] Surma should be imported from Mount Sinai wherever it is to be used by Muslims. Their tradition is that when God showed his face to Moses on Mount Sinai it set the mountain on fire; when the mountain remonstrated, saying to the Almighty:—"Wherefore has thou set me, the least of mountains, on fire." Then the Lord, turning to Moses, replied, "Henceforth shall your people grind this mountain to dust, and apply it to their eyes that they may better see my purposes in my acts." But the true explanation of the use of *kohl* in the East is the simple physiological one; which also explains the use of *henna* for reddening, also really cooling, the tips of the fingers, the antiquity of this usage of the leaf [of *Lawsonia inermis*] being attested by the epithet of "rosy-fingered" [*ῥοδοδάκτυλος*] so often applied to Aurora in the Iliad and the Odyssey. Aurora is as often

Chairman) trusted that there indeed was a sound prospect of the revival of artistic lead work in this country. What was wanted was that some disinterested and enthusiastic person, with the originality and instructive taste of a born artist, should sacrifice himself to the redemption of the lead craft of this country in the same public spirited and successful manner in which Mr. Starkie Gardner had devoted his life to the artistic revival of iron work: and the artist at hand for this benificent, national, and truly patriotic service was Mr. Lethaby. He had put a charming device on the title page of his volume on leadwork, the seven planets, with Saturn differenced by having the sickle of Cronos cast round it; and he hoped that henceforth Mr. Lethaby would distinguish all the objects produced in his lead-foundry by stamping this device on them as a "trade mark."

"The *golde* is titled to the Sonne,
The Mone of *silver* hath his ["Deus-Lunus"] part,
And *iron* stondeth upon Mart,
The *copper* set is to Venus,
Quicksilver to Mercurius,
And Jupiter the brass [tin] bestoweth,
And *LEED* after Satorne groweth."

In conclusion, the Chairman said he would call upon a learned and reverent student of art then present, Alderman Sir Stuart Knill, to follow him in the few observations of grateful appreciation he had ventured to make on Mr. Lethaby's most instructive and most delightful paper.

Alderman Sir STUART KNILL, Bart., said as a past master of the Plumbers' Company he was very pleased to be present that evening, and to offer his congratulations at having such a paper read. Although the Guild of the Plumbers of London was at the present moment exerting itself to improve the sanitary and practical work of plumbers, inasmuch as so much bad plumbing had taken place, and there was an absolute necessity for the public health that something better should be done, the Court had not had their attention particularly turned to what they desired especially to promote in plumbing work, viz., artistic plumbing, as it existed in the middle ages. At almost all their meetings, however, they were constantly speaking upon that. Although their first duty now was to work for the benefit of the health of the people, it was the duty of craftsmen to make themselves artists, as tradesmen of all crafts were in the early ages. Unfortunately by the loss of apprenticeship, and through the introduction of so much competition and mechanism, the artist at the present time was in the background. But the Guild was doing its best to raise the tone and footing of the plumbers in order that they might, at some early date, return to the art of their forefathers. In Germany and Belgium at the present day some beautiful remains of lead work could be seen. The Plumbers Company was showing its devotion to lead by using it on the Master's badge. This badge consisted, as Masters' badges generally did, of gold and enamel, and there was mounted on the plate of gold a Tudor rose of lead, in the centre of which there was a ruby. With this feeling impressed upon the members of the Guild they would do their best to restore the art of the plumber.

Mr. STARKIE GARDNER said he was surprised to hear it suggested that lead pipeheads could be made as cheap as iron, though he hoped it would turn out to be true. His own impression was that it was the cost of lead which kept it from being generally used. Only last week he was at St. John's College where a stone house was being built at a cost of £2,000, and the architect felt obliged to use iron in preference to lead in order to keep down expenses. If Mr. Lethaby would demonstrate that lead could be brought down to a commercial price, a great service would be done to the country.

Mr. LETHABY referred to a beautiful specimen on the table of an escallop shell, which, he said, did not cost 1½d. Of course, the date-plates over a house would cost more than that.

Mr. HUGH STANNUS remarked on the many uses of lead in the Arts. These might be divided into three categories. Firstly, was its independent use as a cast metal, in the making of such objects as statues, fonts, cups, &c., which were often also made of bronze or cast-iron; that is, it was used as a *cast* metal. Secondly, was its accessory use in *sheets* (sometimes rolled and sometimes cast) as a covering on other objects, as for instance on the timber boarding of roofs, or the wooden spires of the mediæval period. It was more convenient than slate or laminated stone, owing to the large size of the sheets, which were often seven or eight feet long by about two feet wide. The rolling up together of the overlapping edges of contiguous sheets, for the purpose of rendering the joints water-tight, produced the "rolls," which, so far from being any eyesore, were generally decorative in appearance, and helped to give "scale" to the roof. Thirdly, was its strictly decorative use in the making of small ornaments or "mounts" which were added to other objects, as for instance the additional leaves, fashioned out of sheet-lead and fixed round the bell of a capital, or a pinnacle. The crestings of roofs, such as the beautiful one at Holyrood, could be stamped in relief, petal by petal, or scroll by scroll, and joined together with great facility by soldering. This facility of joining by soldering and the extreme ductility and pliability were the two great advantages of lead over other metals. He had been interested in the account of Mr. Lethaby's experiments at the school, in the impressing the pattern of the shell into

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phrased "saffron robed" [κροκόπεπλος]; and there can be no doubt of the immemorial vogue of yellow colour throughout the East for the robes of women and linings of tents has also a physiological origin, yellow being the coolest wear of all colour. The yellow robes of the Burmese *porigis* originated in the dirt-dyed rags of the primitive Buddhistic ascetics.

the sand ground prepared for casting the lead sheets in. This was analogous to the method adopted by the bell-founder in the storiation of bells. The outer mould of the bell having been made, the founder, furnished with a set of the 26 letters, each projecting in relief from a small block, takes them one by one, according to the required inscription, and with a smart blow of a small hammer impresses them in the mould, and so they stand out in the bell when cast. In conclusion, he said he had never had the good fortune to work in lead, a material that lent itself so readily to artistic treatment. This decorative side of lead work had evidently appealed to Mr. Lethaby, whom he envied for his opportunity in it, and whom he begged permission to thank personally for the interesting and almost exhaustive manner in which the whole subject had been brought before the Applied Art Section.

Mr. J. HEBB said the only thing which occurred to him that Mr. Lethaby had omitted to mention was the lead figures which were popular at the end of the last century. There was once in Clement's-inn one of a negro bearing a dial on his head, which is now in the Temple-gardens. About this, there were a great many stories told as to how the negro came there, that he had been a slave of some inhabitant of the inn, and had put a hot dish upon his head with the result that he was immortalised in lead. Lead lent itself very badly to plastic art as, unfortunately, it warped in the sun.

Mr. NELSON DAWSON said he should have liked to have heard a little more of the method of treating lead. He did not know whether Mr. Lethaby would allow anyone to attend the school to which reference had been made.

Mr. LETHABY said he should be glad to welcome any visitor at the Regent-street Polytechnic any evening after 7 o'clock.

A hearty vote of thanks was accorded to Mr. Lethaby for his interesting paper and the meeting adjourned.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 7, 1897; The Right Hon. Lord BELPER in the chair.

The following candidates were proposed for election as members of the Society:—

Calthrop, Everard R., The Barsi Light Railway Company, 56, Naylor-street, Liverpool.
Griffiths, F. B., Barbados, West Indies.

The following candidates were balloted for and duly elected members of the Society:—

Hinds, Henry, 57, Queen-street, Ramsgate.
Scalé, James Bernard, 48, Bedford-gardens, Kensington, W.

The paper read was:—

DAIRY PRODUCE AND MILK SUPPLY.

BY M. J. DUNSTAN, M.A., F.R.S.E.

The present depression in the agricultural industry being greater than any of its predecessors, has caused a general overhauling of the methods and results of the industry, and a cloud of criticism on these methods emanating from individuals more or less qualified to pose as expert critics. In turn the British farmer is held up as a model of good farming, and as an awful example of Conservatism. On one side we hear that no farmer in the world produces more grain and meat to the acre than he does, and on the other we hear that he is beaten by his continental and American brethren in the methods of production, more especially of economical production.

There is truth in both these views; but in making these sweeping statements, too little is taken into account of a great many facts connected with the social status and environment of the British farmer, and of his foreign competitors. It is a curious fact, and yet it is a fact, that the great majority of the industries for which the farmer acts as the raw-material producer are flourishing and show little or no sign of depression, whilst the farmer is struggling against a competition which almost forces him to sell his produce below the cost of production, and the remedies suggested to improve his condition are either impracticable or else of such a partial and unsatisfactory nature as to fail in securing any but a very faint-hearted acceptation by the general body of agriculturists. A more divided and less organised industry than that of agriculture it is impossible to name; the very nature of a farmer's calling compels him to lead a more or less isolated existence, and causes an independence and a distrust of combination that, while having its advantages, renders him a somewhat easy victim to outside combinations. There is no doubt that there is among some classes of farmers a great lack of business capacity, and it is a question whether this capacity will not have to be very largely developed among the class if the combinations of business men who trade with the farmers' produce are to be successfully dealt with. The perishable nature of some of his produce, the slow turnover of the greater part of his capital, the difficulty of suddenly changing his methods or his produce to accommodate the fluctuations of market demand, are all factors against his success, and in these days when small profits and a rapid turnover of capital are some of the conditions of success, the industry is handicapped by its want of adaptability. Of the many critics the British farmer has had during the later and more severe years of his depression, the great majority have turned their eyes to the foreign imports of agricultural produce, and have with a curious unanimity, fastened upon the subject of dairying, more especially of cheese and butter production, as the weakest part of the agricultural produce system in this country. Poultry and fruit have also been recommended to his notice for more assiduous attention, and he has regarded his critics and their suggestions with a distrustful air founded on their—as a rule—lack of any experience save that of statistics, in these matters. As a matter of fact the dairy, the poultry yard, and the orchard have been to the farmer in the past, mere details negligible in the carrying on of the more important businesses of corn and stock raising, and to expect a farmer to know the number of pounds of butter produced, or the eggs, or the fruit details of his farm, was demanding too much of a man who had other more serious work to do. Now all is changed: corn and stock prices have reached a figure never dreamt of by the old-time farmer; three bullocks must be fattened now to produce the profit which one formerly produced; wheat is half the price it used to be; and, in short, England, as the best market of the world, has attracted produce from all the globe to her shores, and the farmer's competitors, in a great many cases more favoured by conditions than he is, are flooding the market with their produce of prime quality and condition. It is a time of anxiety for the home producer, and he must set his house in order and reduce his cost of production without deterioration of his quality. He has much to learn, if not in the greater matters of farming, in the smaller details; and it is a day for him of small profit, obtained only by the most careful attention to every penny of his expenditure. Those industries of butter-making, &c., must take higher place in his estimation, and the quota they yield on rent day will not be any longer a negligible quantity. As has already been said, each department of farm produce has competitors for the British farmer who are favoured largely by natural conditions—California, with its wonderful climate, sends her fruit; Argentine and Australia, with their easily obtained pastures, send beef and mutton; India and Russia, with their favourable soils, send wheat; Italy, Austria and France compete with eggs and poultry; whilst butter and cheese come from almost all the countries of the world. The English farmer in time will stiffen himself to meet and overcome this competition, but how many victims of depression will there be before this is the case. Denmark is a country which has shown how she, with her comparative absence of natural facilities, can organise a trade in dairy produce and bacon, which is one of the wonders of the last ten years, and there is little doubt that we, in this country, moving slowly, it is true, will rise superior to our present difficulties and make the utmost of our splendid markets close at hand.

The remedy for this depression is said by many to lie in co-operation, and it is with a department of this co-operation that my paper to-night mainly deals. I can claim but a small measure of originality for my remarks: the subject has been so well thrashed out from so many points of view that to many of my hearers I fear what I have to say will be mere recapitulation; but I feel that so much has been said and written on this subject of dairying by people who have merely skimmed the surface, that a plain exposition of all the facts, and the logical deductions from these facts is sometimes necessary, in order to insure that we do not go off on a fresh enterprise without having duly calculated the cost. Co-operation among farmers may be established in several ways. Co-operation in production of the raw material (in farming); co-operation in production of the manufactured article (in cheese or butter making); co-operation in the sale of farm produce other than dairy produce; and co-operation in the purchase of implements, seeds and manures. Of the first of these systems of co-operation (in farming) I need say little. The many trials that have been made have not been conspicuous by their success, and I need only refer my hearers to Mr. Rew's paper on the co-operation in the sale of farm produce for a history of the efforts in co-operative farming. One more case of such farming has lately come under my notice, and success has not been its most prominent feature. Co-operation in the sale of farm produce is now on its trial in an extended way, and we must all of us wish it a success, started as it has been by one who, above all other objects, places the prosperity of the agricultural industry as most deserving of his undoubted great capacity and untiring energy. There have been many outcries lately to abolish the middleman and his profits, and to bring producer and consumer together to bargain to their mutual advantage. Such a scheme has its attractiveness but I doubt its practicability; the middleman seems to be a necessity in most commercial transactions when his dealings are not of that purely speculative character which are of such frequent and disastrous occurence in the United States. One result of the movement of Lord Winchelsea's may be that the agricultural industry will become more organised, and once this result has been accomplished remedial measures for the depression will meet with a greater chance of a fair trial as to their efficacy. Co-operation in the purchase of materials, implements, &c., used in agriculture, has been tried with distinct success, the chief difficulty in its way being the cash system which must obtain. This form of co-operation has perhaps been most tested, on account of the small risk attaching to it, and it is in that respect a form which hardly tests the principle—for we are all ready to share in profits, but apt to make ourselves scarce on the day of dividing losses—and a system where all may profit and loss is impossible commends itself to everyone.

Co-operation in dairying may take the form of milk selling, cheese or butter making, but before going into these, a few statistics on the subject of our whole milk supply and the supply of home and foreign dairy produce are necessary.

The United Kingdom at the present day has a population of some 39,500,000, and according to carefully compiled calculations, there is consumed per head of the population 15 gallons of milk, 15 lbs. of butter, and 12 lbs. of cheese, making a total consumption of 591,779,400 gallons of milk, 5,283,745 cwt. of butter, and 4,226,978 cwt. of cheese; reckoning the milk value of this butter and cheese at $2\frac{5}{8}$ gallons to 1 lb. of butter, and $1\frac{1}{10}$ gallons to 1 lb. of cheese, we obtain a total milk equivalent of the butter and cheese consumed in the United Kingdom of 2,074,186,935 gallons of milk, this quantity being $3\frac{1}{2}$ times that of the whole milk consumed, whilst the milk equivalent of milk and milk products consumed in the United Kingdom is practically 2,666,000,000 gallons. The source from which most of these figures have been calculated is Mr. Rew's admirable paper before the Statistical Society some four years ago, and the inquiries I have made for the purpose of ascertaining the accuracy of these figures to-day, do not justify me in any great deviation from them. The consumption of milk as whole milk is on the increase, and might with advantage to the health of our population, more especially of the younger part of it, be very considerably increased; but the consumption of one-third of a pint per day per person was obtained by Mr. Rew after a most exhaustive inquiry into the question, and I do not feel that I am justified in changing that figure. To repeat them, we consume 591,779,430 gallons of whole milk, 5,283,745 cwt. of butter, and 4,226,996 cwt. of cheese per year, or a total milk equivalent of nearly 2,666,000,000 gallons. Of these quantities only 22,776 gallons of whole milk were imported, a practically negligible quantity; whilst of butter, 3,037,947 cwt.; and of cheese, 2,244,535 cwt. were imported, leaving 2,245,798 cwt. of butter, and 1,982,461 cwt. of cheese for home production, so that the total milk and milk equivalent of imported produce is 1,169,683,130 gallons, and that of home produced 964,503,805 gallons, or the ratio according to these figures of home produced to imported is as 1 to 1·29. The total milk production of the United Kingdom is therefore the milk equivalent of the dairy articles of home production plus whole milk production, or 1,495,283,235 gallons. According to the annual return of live stock in the United Kingdom in 1896, 3,959,087 cows or heifers in milk existed, if we deduct 10 per cent. of this number as unproductive and give to the remainder a milk production of 400 gallons per annum—a figure that I am led to take after careful inquiry on the subject—we obtain the figure 1,424,271,600 gallons, a number closely approximating to that already arrived at as the milk production calculated from consumption. To provide then the total quantity of dairy produce imported into the United Kingdom (milk equivalent 1,169,683,130 gallons), we should require roughly an addition to our dairy live stock of $3\frac{1}{2}$ million cows, and of the capital invested in farm live stock of some £45,000,000, and a very large addition to the capital invested in agriculture for buildings, apparatus, &c. The acreage at present under cultivation in the United Kingdom is 47,882,099 acres, so that the ratio of dairy stock to acreage is as 1 to 12, were we to keep sufficient dairy stock to supply all our needs, the ratio of stock to average would be as 1 to 6. In Denmark the ratio is as 1 to 6, and in Holland the ratio rather less (as 1 to 5¾), and in these countries there is no breeding or meat or corn production of any consequence, or in fact any more important agricultural industries than dairying. If, then, we defer to the demand of these enthusiastic reformers of British agriculture, who state that we ought to and can produce all the dairy produce we consume, we must establish these 3½ million extra of dairy stock, and in consequence of this increase we must withdraw some other part of our agricultural production. I fancy if this were done the faddist would merely change his cry from "Why all this imported dairy produce?" to "Why all this imported meat and corn?" And were we to make this gigantic alteration in our system of agriculture, should we, as farmers, be better off than we are now? I think not. We should have all our eggs in one basket, and if an accident happened we should be in a terrible plight. No, what we want in the dairy industry is, at all events in my humble opinion, not this extravagant extension of our system, but the organisation of our present system and such extension as is justified, so that English or British produce may sell on as good or better terms than foreign, and we want this reproach of English farm butter taken away. The quality of imported butter is to my mind distinctly overrated by the English butter-eating public, but this taste for foreign butter has been fostered by the inferior quality of a great deal of the English farm butter, and this inferiority is due to many causes. Want of skill or of knowledge of all details of manufacture is one, and perhaps the most important, but carelessness and indifference to the quality produced is another; the milk is made into butter in a great many cases at all events so as to have something to sell. Butter-making is not the trade on which the livelihood depends. In some districts in Leicestershire, for example, the farmer makes his living out of cheese. Oddments of milk before the cheese-making season begins, or during its progress, are made into butter and disposed of anyhow. In other districts where rearing is the practice, surplus milk is forced into butter, and this butter sells at any price, as the difference between a high or low price on the few pounds made is of practically no moment to the farmer. Later on in my paper I shall suggest a method for the organisation of this branch of butter-making. Coming first to the methods open to the farmer of disposing of the produce of his dairy cattle, they are as follows:—

1. The retail sale of milk.
2. The wholesale sale of milk.
3. Home manufacture of butter or cheese.
4. Factory manipulation and grading of home-made products.
5. Creameries—(*a*) taking whole milk; (*b*) taking cream.
6. Cheese factories.

Of these we must dismiss the first two with few comments, as they are outside the scope of this paper; but with the above figures before us, we must conclude that the main object of dairying in England must be to supply our huge population with whole milk, since there is no doubt that the consumption of milk per head of the population at 15 gallons is too small, and we should welcome any facilities, be they reduction of the cost of production or of distribution, which would ensure a perfectly pure unadulterated supply of this important article of human food to the masses of the people; but this is too large a question to be dealt with in the compass of this paper. Suffice it to say, that as far as the pocket of the farmer is concerned, these two methods of getting rid of his milk are, if carried out under satisfactory conditions, the most remunerative, but too often is it the case that such a milk trade is carried out without due regard to its effect on the land, and I know of no way in which the condition of the land can be so thoroughly drained as by the method of milking out without due return in the shape of manure.

Every cowkeeper, within a fairly easy reach of a station and of a town, turns his attention first to the production for sale, retail or wholesale, of whole milk, and in districts, such as these, winter milking is of importance, whilst in districts devoted to the breeding of young stock, winter milk is of comparatively small importance. In cheese-making districts, the summer milk is made into cheese, and winter milk (what there is of it) disposed of whole, where such disposal is practicable, or it is made into butter, and so the dairying question in England is a far more complex matter than one would at first sight imagine, and very different to the same question in Denmark. There is one point of which I am assured, though I daresay many of my hearers will not agree with me—far too many farmers and cowkeepers are too anxious to send their milk away, and, being entirely dependent on the wholesale trade, they are on their beam ends when an extra flush of milk comes, or when some of these unforeseen accidents, that I believe even do occur in the whole milk trade, happens. I believe that if—I will not say a factory—but an establishment were erected in districts where the wholesale trade is in general use, to deal with surplus milk or milk unsaleable in London or other large towns, so that this could be converted into butter or cheese, a profitable return would be made, or, at all events, less loss would be incurred by the milk producers, through the hasty manufacture of low grade produce.

The next means of disposal, by the manufacture of butter or cheese on the farm, is remunerative or not according to the manner of disposal of the produce. In regard to butter I know of many farmers who are doing an excellent trade by means of a good private custom—a far better trade in fact than could ever be assured to them by trading through a factory—but such cases are the exception and not the rule. The quality of the best made farm butter is in my opinion distinctly better than that of the factory-made article as it must needs be, since the conditions of milk production, and all the subsequent details of its conversion into butter, are under the eye of the maker, and the milk, being of one quality, and that a high one, is more likely to give a uniform high quality butter than the butter derived from factory-mixed milk, which is produced under different conditions of feeding and management. In the manufacture of what I may call the less-concentrated article, cheese, an individual farmer can manufacture a sample of cheese of higher quality than can be produced under the factory system—but by these statements I must not be understood to say that the average farm butter or cheese is equal to or superior to the average factory produce—the case is far removed from this, and it is to raising the quality of the average that attention must be paid. A cheese maker, sending a greater bulk of produce than if he made butter, is on account both of its less-concentrated and better-keeping character, in a stronger position with regard to the market, and as high quality cheese of any variety is an article appealing to the wealthier classes, the returns to such a maker will be far superior to the returns he would get on the factory system, where the really primest qualities are seldom made, but the average quality is distinctly good. As the mass of the population do not require and cannot afford the really primest quality of cheese, the demand for factory cheese will always be great, and the returns from our English and the American and Canadian cheese factories show that the demand is increasing. There is room for a much greater consumption of this article, as in this country cheese has not yet its proper position as an article of food, being used more as a relish and a luxury instead of a food proper, and the low-priced meat is consumed in preference to cheese as a food by the working-classes. The manufacturers of the lower and smaller quantities of cheese and butter are those to whom the factory, or some organised system, should appeal, as these small quantities, finding their way into the open market (the total butter taken in by 13 or 14 farmers on a market day sometimes amounts to no more than 40 lbs.), and in competition with foreign products, which, both in bulk and quality, are superior, obtain a lower price. The price obtained for the foreign produce does not at first sight appear remunerative, and so the questions that present themselves to any one investigating this question from the farmer's point of view are—(1) Will it be possible by a large extension of the milk-producing industry to obtain a more stable and better return from an acre of land than by the system of corn growing and meat production? (2) Assuming this to be the case, by what method is the best return to be obtained; by individual production of dairy articles by co-operative production, or by the production of milk and its subsequent disposal to a manufacturer of dairy produce? (3) Assuming the answer to my first question to be in the negative, or rather in a qualified affirmative, under what conditions is a co-operative creamery or cheese factory most likely to succeed if it only deals with the present production of milk intended for manufacture into butter or cheese, or with a slight increase on that production? To answer these questions exhaustively wonld involve a far longer paper than I intend to give this evening, but without going into too much detail I will try and give the salient points of the answers according to my opinion and experience. Taking butter-making in this country first, we may fairly say the factory system is in its infancy, and the greater quantity of butter made is made by the private dairyman or woman. The best samples of this butter never come into the public market, being disposed of privately at remunerative prices varying in Notts from 1s. 1d. to 1s. 6d. per lb. The amount so disposed of is regulated by the winter output in the majority of cases, the surplus of the summer make finding its way sometimes into the markets, and sometimes into the private trade by displacing the foreign butter. The lower qualities of farm-made butter are sold in the markets or disposed of to the local grocer, who as a rule gives one price for butter which is small and irrespective of quality. I have obtained from several sources the market prices for this butter, but it would be misleading to quote these figures, as the price does not represent the price of English butter, and varies between such wide limits, according to the conditions obtaining in the market, that deductions from these figures would be certainly erroneous. One fact stands out clearly—that were butter made and sold under these conditions on any larger scale than at present, the loss to the producer would be increased proportionately. This butter may be made by cowkeepers who are rearers, and have a surplus of milk to dispose of in the summer months, and butter making—as it leaves the skim milk for the stock—is the most advantageous way of disposing of the milk. The cows are only maintained during the winter, little or no artificial foods or foods for milking purposes being used, the milk yield in the winter being of practically no account. In a district where this system of butter-making is pursued, I would suggest the establishment of a small depôt to which milk could be brought by the neighbouring cowkeepers, sampled for its quality to be ascertained in order to fix its value, then separated, the separated milk returned and the cream ripened, churned, and the butter made up by the same hand every day: such a system would, by producing uniformity of make as well as a bulk sufficient to tempt the merchant, be likely to be more remunerative than the present system, and the amount of money obtained for the butter would fix the price of the fat or cream left at the depôt. A factory on the large scale would certainly be out of place as there being little or no winter milk, a large expenditure in the way of permanent apparatus, labour or rent would not be incurred, and owing to only a summer supply of butter being manufactured, prices would rule lower than if manufacture were continued through the winter. The arrangements could be more or less temporary, and no permanent staff would be maintained, and the more expensive apparatus, separator, churn and worker could be either obtained on hire for the season or purchased by a suitable arrangement. The object of such a system would be merely to raise the quality of the product and to do away with labour of so little butter being marketed by so many hands, and the result might be, if conditions were suitable, to encourage winter dairying and to establish a permanent creamery. The skilled labour, that of the actual butter maker, can be easily obtained now-a-days with our numerous dairy schools and places of instruction for those engaged in dairying. It may be urged against such a system that individual effort is destroyed, but the cowkeeper would be free to devote his energy to the production of a higher quality of milk and towards improving his stock and holding, he would be free from the labour of making, and also from the responsibility and trouble of marketing his produce. I have no personal knowledge of this system having been tried in this country, but I hear that in some parts of Denmark it has been successfully tried as a preliminary to the factory system on the large scale. One objection, and a real one, is found in most villages to the butter-making passing out of the farmer or his wife's hands, and the objection generally comes from the latter, as butter-money is a species of what in other social strata is called pin-money, just as egg-money is, and by the passage of the making to other hands, and the monetary return coming back to the farmer, there would seem a chance of some of it being absorbed in the process. Of course, a depôt of this sort might, under capable management in touch with a good local market, embark in other dairy enterprises, such as the manufacture of soft cheeses, sale of cream, &c., which are more profitable than butter-making in the summer months, but all this needs organisation and enterprising business management.

Coming now to the system of manufacture on a larger scale, we may divide the system under the following heads—Grading factories, proprietary factories, co-operative factories, and a further sub-division of these last two can be made according as to whether the whole milk or cream is brought to the factory. The word "factory" has been objected to as it may bring the establishment under the Factory Act, and that of "creamery" has been suggested as a substitute, whilst other authorities on the subject prefer the term "co-operative dairy" to "co-operative factory." By the term "co-operative factory, creamery, or dairy" I understand an establishment erected and maintained by those who bring their milk either with their own money or by means of a loan obtained by them at a fixed rate of interest. The milk suppliers frame the regulations for the conduct of business, and fix the prices to be allowed for milk or cream brought, and for skim milk, buttermilk, or other bye-products taken away. To deal with grading factories first—these exist in small numbers in this country, but the largest are to be found in France in the districts of Normandy and Brittany. The grading factory is owned by an individual or company, and the agents, often women, attend all the local markets within a reasonable distance. The farmers or butter-makers of the district bring to these markets the butter churned at home uncoloured, unsalted, and in the lump, simply wrapped in a clean cloth in a basket. The agents having fixed the prices of the different grades of quality which vary in number according to the size of the factory, but which may be as many as six, apportion each sample of butter brought to them by its taste, &c., to the proper grade and pay for it in cash accordingly. It s then removed to the factory, again graded, the different grades being kept separate, salted, coloured, and worked according to the demand of the market to which it is to be sent.

Such a factory needs a very large amount of material to deal with and butter-making must be general in the district in which the factory is established, and it is also necessary of course that butter be made all the year round. The drawbacks to the buying of English butter by the wholesale merchants in London and other large towns are several, but one of the most important is the difficulty of obtaining the winter supply. In Brittany and Normandy, where this grading factory system obtains, the butter-makers lay themselves out for winter production, and the winter output is greater than the summer—the lateness of the seasons in their districts enables winter dairying to be carried on under more economical conditions than is possible in this country, and this is of course a most important consideration. The advantages to the farmer of such a grading factory system are obvious. The farmer is encouraged to make the best butter he can by the fact that the better the quality the better the price he obtains, and he also is encouraged to produce the best quality of milk, and the factory, having only to deal with butter, has none of the many leakages of profits that may occur when milk is dealt with. The butter again is of absolutely uniform quality in the different grades and the chances of an inferior sample spoiling the whole make are reduced to a minimum.

When the supply of butter exceeds the demand, the surplus is salted and potted down for the export trade, and so there is always a margin available for the chance extra orders from this country that may come in. The great bulk of the butter, fresh butter from these French factories, is sold in the London and south of London districts, where the demand for a fresh, unsalted article exists, but I see no reason why a proper organisation of the butter trade of this country should not result in fresh butter being sent in from our own country districts to compete with the foreign imports—the market is nearer and the time of delivery likely to be shorter. It has been stated that the very finest samples of English butter that you can produce, carefully made in a dairy, would be as fine as any butter to be found in the world, but the average class of it would not be anything like equal to the average quality of our best Brittany butter. When we consider that the price of fresh butter differs from that of salt by 1½d. and 2d. per lb., it would seem as though a well secured fresh butter trade would be financially successful in this country, but of course the greatest care must be taken to secure the absence of all conditions that might influence the character of such a delicately flavoured article as fresh butter.

In this country there are several grading factories of a similar kind to the French running successfully, but the area of their useful introduction must be limited in this country as long as winter milk production is more or less limited to supply the whole milk trade. There are also blending factories for lower grade butter existing in this country, similar to the ladling trade in America, but in these the lowest qualities of both home and foreign butter, even if rancid and unfit for consumption, are bought up, purified and doctored to produce an article selling at 10d. or 1s. per pound. I understand, though I cannot fairly say that the figures have been accurately put before me, that the cost of such grading is about 1¼d. per pound, and so a handsome profit should be ensured to the undertakings.

We next come to the factory or creamer

system, where the milk or cream is brought and manufactured into butter. We will for the present pass over the question of co-operation in management, to which I will allude later, and at first consider the method of manufacture. The milk produced on the farms is brought to the creamery once a day, strict regulations concerning the cooling or refrigerating being enjoined on the producers. Samples proportionate to the bulk of each lot are drawn, and the sample tested for cream or (as is preferable) fat content. The milk is then heated and separated, and the skim milk after pasteurisation and cooling returned to the farmers in the proper proportions, a fixed price being always charged. This return of separated milk, or some similar method of disposal whereby the onus of its disposal is not on the shoulders of the manager or directorate of the creamery, is the vital point in the management of a creamery, and I have known of cases where, this point having been neglected, the profits on the butter have been eaten up by the loss on the separated milk. Another vital point, sometimes also overlooked in the erection of a creamery, is an efficient system of drainage. The waste products, washings, &c., from a large dairy, are most difficult sewage material to deal with, and unless special provision be made for their disposal at first, a great expenditure in special drainage facilities will be needed. The cream after separation is then cooled and ripened to the proper degree, churned and worked, being salted and coloured to the special demand of the market where it is to be disposed of. The advantages of the creamery system, as regards the butter produced, are the uniformity of flavour, salting and colour, and the marketable quantity produced. The disadvantage from the same point of view are the liability for occasional disturbances of the quality, unless special precautions are taken to ensure a high standard of milk production in which no taints, induced by improper feeding or management, appear.

It has been stated by butter experts, on whose experience and veracity I place the highest reliance, that a taint may appear in butter through the above-mentioned causes, which is quite unnoticeable either in the milk or cream. Hence the grading factory has the advantage over the last-mentioned system in that the raw butter is tasted and tested, and there is no escape for a tainted sample. Were it possible to grade the milk or cream in a similar manner, the ordinary creamery butter would not be subject to the drawback I have mentioned. Creameries of the type I have already mentioned may, of course, be proprietary or co-operative; under the proprietary system the farmer takes the price for his milk or cream fixed by the buyer, and takes back his skim milk, having no further interest in the concern. The great advantages he obtains from taking his milk to such an establishment are monthly payments, sweet skim milk for calf rearing and pig feeding, and last, but not least, payment for his produce according to its quality. Since the introduction of the Babcock system for milk testing by its fat content, such analysis has been made quite simple and needs little skill for satisfactory accomplishment. The farmer is consequently urged to produce quality rather than quantity, since both, from his point of view, as a carrier of the milk, and of return carrier of the skim milk, and from the creamery managers' point of view, the smaller bulk or milk in which his cream is contained, the better, since there is less water to be carted and dealt with. In the co-operative factory which is practically owned by the milk suppliers, the co-operators receive a price for their milk monthly, and the net profits of the undertaking are divided half-yearly among the co-operators in the proportion of the quantities of cream they have delivered—the co-operation once secured may be beneficial in many ways to farmers in the purchase of seeds, manures, implements, &c., in bulk, and also in the disposal of other kinds of farm produce on a large scale. This co-operation has been urged on the agricultural industry for some time, and a short account of the movement in Ireland may not here be out of place, since it may fairly be said that the movement has been quite successful in that country and has raised enormously the average quality of the Irish output of butter, bringing increased profits to the milk producers and a greater feeling of security generally to the co-operative creamery system. We must, however, not forget the fact which must be given a prominent place in all discussions on the dairy question that the trade in whole milk in Ireland, as in the foreign countries I have already alluded to, is a small one, and butter or cheese-making are the most remunerative methods and in fact the only methods for disposing of milk. In regarding the co-operative creamery movement in Ireland we must also not lose sight of the status of the Irish farmer and the size of his holding, and all these points must be taken into serious account before we decide on the advisability of adopting such a system in this country.

The original co-operative dairy society in Ireland was at Drumcollagher, and the object was butter-making from the milk of the co-operators, and in the first two years it showed considerable profits on the turnover—some 7½ per cent.—then as competition increased and as milk was not paid for according to its content of fat or quality, adulteration took place, and the financial results nearly amounted to bankruptcy. The cost of this creamery—I am quoting from Mr. Anderson's evidence—was £973, and it took the milk of 3,000 cows. The cost of the factory might have been reduced 20 per cent. had all the arrangements been satisfactory, and we are given the figure of £700 to £800 as the cost of building and equipping a factory for the milk of 3,000 cows. The experience of the Drumcollogher factory led to the most useful results, for in some three or four years no less than 30 of these co-operative societies were at work. In 1894 the total paid-up share capital was £15,468 and loan capital £6,061, and the buildings and plant were valued at £25,266. They dealt with 9,000,000 gallons of milk, and £132,500 was paid for it, giving an average price for the milk of a trifle over 3½d. per imperial gallon (not including the value of the returned skim milk). The produce of butter realised £151,852, the average price being nearly 10¼d. per pound. The shares in these co-operative creameries are owned for the most part by the milk suppliers, but there are in each establishment a few non-milk suppliers who hold shares, consisting of the local landowners and others who wish to help on the establishment to be a benefit locally. These as it were sleeping partners are entitled to five per cent. on their capital, and this is a first charge on the profits. The other shares, which are of the value of £1, are held by the farmers, who pay for their shares by instalments—5s. per call, and there are four calls. The calls can be worked off in milk, either by the shareholder receiving a less price for his milk, or by supplying his milk free until the value of the share is worked off. The liability of the farmer is limited to the amount of his share, and the societies are registered under the Industrial and Provident Societies' Act. The quality of the milk sent is not high, as is shown by the fact that 2·55 gallons of milk were on an average required to produce one pound of butter, the variation in the fat yield of the milk being from 4·37 to 2·85, and the average percentage for the year in which the figures have been taken 2·95. The sale of the butter is accomplished through the federation of the co-operative societies, the commission charged being 2½ per cent., the sales amounted in 1894 to some £64,000. A feature of these co-operative societies is the share of profits, 10 per cent. which is allotted to the workers—these are manager and two or three assistants in the dairy, and engine-driver. This share of the profits is divided among them in proportion to the wages they draw, and it is not paid in cash, but accumulates as shares, or can be withdrawn as cash, should they leave the society or be involved in misfortune. The remaining profits, after deduction of those I have mentioned, are divided among the suppliers of milk in this way, that the milk supplier, who is not a shareholder, only gets one half as much in the pound as profits as the milk supplier who is a shareholder. This share of profits to the non-shareholder is not paid in cash, but accumulates until the value of five shares has been made, and then, *nolens volens*, the non-shareholder becomes a shareholder. The difference between the half and full value of the dividend is placed to the reserve account. All payments of profits are made on the same system—shares are allotted, or payments on account of shares. The directorate is elected by the shareholders, and comprise a chairman, and from four to eight members, and the accounts are audited yearly by an independent auditor. The federation of these societies acts as adviser in any difficulties that may occur locally, and generally fosters the growth and sound working of the different co-operations. The figures supplied to the Royal Commission on the farmer's profits from these societies, show that a cow supplying 435 gallons of milk at the price already mentioned, 3½d., gives a return to her owner of £6 8s. Eighty per cent. of the milk returned as skim or separated milk, at a price of 1¼d. per gallon, will add £1 15s. to this figure, and if we add the calf at 15s., we get a total return from the cow of £8 18s. about. Mr. Anderson states, as a result of his experience, that the difference between the returns of a farmer who makes his butter at home and of one who sends it to the factory is on an average £1 2s. 4d., allowing the price of home-made butter to be 8d. per lb., and that of the factory-made article 10¼d. The cost and labour of sending the milk to the factory or creamery are set against the cost of packing, salt, &c., at home. The price of the unit of fat in the milk is fixed by the price of butter, allowing 1d. per lb. for working expenses, and the difference in value is made up at the end of the half year when the profits are declared. This sketch of the Irish co-operative movement shows what may be expected of an extension of the dairy movement on a large scale in order to compete with the foreign produce, and although such a system in a country where butter or cheese making is almost a necessity in order to dispose of the milk, has produced considerable improvement in the position of the Irish farmers, I am not of opinion that an equal improvement in the English farmer's position would result if the method was transferred to this side of the water. The market we must seek in England under present conditions, if butter-making is to pay, is the higher class market, where butter realises over 1s. per lb. wholesale—with butter at 10d. and 11d., and milk at 3½d. to 4d., I consider wheat at 30s. and meat at its present low price almost equally unremunerative. As to the answer to the question why the Irish farmer can produce milk at this cost with a profit to himself whilst the English farmer cannot, I will deal with that at the close of my paper, and I trust that some further light may be thrown on the subject by the speeches of those who will criticise my remarks. I have so far instanced the French and Irish systems of dairy production. In neither have I gone into the utilisation of the bye-products of the dairy, in calf rearing or pig feeding, since this, although a most important branch, cannot be dealt with in the compass of a paper of this length. Sufficient to say at present that this utilisation of bye-products can be made an additional source of profit to the milk producer if properly and systematically carried out. Separated milk can also be used as a useful food in the poultry yard, so that were the actual butter-making taken out of the hands of the farmer, or his wife, they would have plenty of scope for their abilities in other departments of farming.

Denmark is over and over again cited as an example to our farmers of the value of co-operation, and the theme is now worn threadbare by hysterical enthusiasts for Danish butter. To understand the question thoroughly one must be conversant with Danish farmers and their life and English farmers and their life, and generally with Danish conditions. I had the opportunity of visiting many farmers in their homes and of seeing their methods of life, and the standard of living was in my experience very considerably lower in Denmark than in England. The Danish farmers are in the main small holders or small proprietors, all the work of the farm being carried on by them, their wives and families, and they are of a different class from English farmers; whether the English farmer will have to become as the Danish is a matter of opinion, at present the Danish farmer in his condition of life is more comparable to the English labourer. In a pamphlet I read some time ago the following passages occurred:—"The Danish farmer to-day is a rich man with a regular business, instead of being discontented and impecunious as so many of our own farmers are in England. In dairy produce in this country there lies a gold mine in which every man and woman may at once take shares to his or her ultimate profit;" and generally the Danish farmer was described as "getting rich on English gold at the expense of the English farmer." The only criticism I can make on these remarks is that signs of opulence were not visible among the class I visited, and work hard and live hard were the order of the day. It is to Denmark's credit that such a gigantic industry has been built up, but the conditions of small holdings and working occupiers are all in favour of cow-keeping and co-operative dairying. Denmark has no enormous whole-milk trade; her land is not adapted to growing corn or meat at present prices, and the State, ever watchful over the interests of the inhabitants, has fostered the dairy industry by methods of education, advice and supervision; so that the people who were at first as difficult to move as our agricultural community, have seen the advantage to be derived from such an industry, and shoulder to shoulder have fought a way for the sale of their dairy produce in this country. Another fact that struck me when in Denmark was the comparatively small number of women's industries, and this, coupled with the absence of towns, was undoubtedly a factor in inducing younger members of a farmer's family to stay at home and help their parents in the work of farming. Under the present conditions obtaining in England, factories erected wholesale on the Danish system would be anything but a blessing to the general state of agriculture. To compete with Danish butter at 10½d. per lb., is at the present moment impossible in England. I do not say this hastily, but after due consideration of the system in vogue here and abroad. Denmark is undoubtedly not what the English farmer calls a dairying country, the land and stock are generally inferior to that of

England, but the care in keeping the milk records and in weeding out inferior animals has resulted in a very great improvement of the milking qualities of the Danish breeds of cattle. The factories, creameries, or co-operative dairies, which are now scattered over the little country in great numbers, are worked on the same plan that I have already described as obtaining in Ireland; there are small differences in detail which it is hardly necessary for me to enter upon, as they do not affect the main position. The greater number of factories with the methods of working of which I became acquainted were co-operative, and the regulations as to feeding of the cattle, general state of health and cleanliness of the cows and their attendants were considerably more stringent than those in force in Ireland. Many of the factories dealt with the produce of under 500 cows, that number being the lowest for which a factory could be erected and profitably worked; and the number of cows owned by the co-operator varied from two to fifty. The milk was of course bought by weight and quality, and the price fixed by the Copenhagen butter price, the monthly payment for milk and the half-yearly division of the profits being similar to the Irish system, which at the outset was founded on the Danish by Mr. Horace Plunkett. The price the Danish farmer obtains for his milk is almost the same as that obtained by the Irish farmer, 3½d. per gallon, with the skim milk returned, or 4¾d. per gallon if the price of milk be calculated outright. The establishments to which cream only, separated at home by the farmer, is brought have met with some success, but the great drawback from a uniform quality of butter point of view is the varying richness of the cream according to the conditions under which it is separated and kept, which causes an unevenness in the character of the butter. Of course such a system involves less carriage expenses on the raw material, but it also entails the extra outlay on the part of the farmer of a separating plant.

If we cannot then under present conditions adopt this system of dairy production, what advances can be made in the industry? First I would say the organisation of our present production of butter. A large farmer can turn out, more especially in the case of cheese, a higher class of dairy produce than the smaller farmer, and there is not the same inducement for the larger man to organise and co-operate as the smaller. Patience, enthusiasm, and a business capacity are needed in him who would organise our dairy industry; and by the combination on the small scale as I have referred to in the earlier pages of this paper of all butter producers in a district, be they large or small, we can surely secure for their produce a better price than they now generally obtain. I of course exclude from this combination those who have a good regular private custom, and I would organise solely for those who now obtain but 6d. or 8d. or 10d. per pound for their produce. I do not say a creamery should be established, but a central farm which could be used as a butter-making station.

With regard to factories on the larger scale, these I do not consider generally feasible, but what I do consider feasible is the erection of factories in specially selected districts where suitable conditions of milk-raising, marketing, &c., exist, and then the object would be not to produce an article to compete with Danish butter, but a superior quality which I know from experience will be gladly bought by our English middle-classes at a price that will bring profit to the milk producer. I have been assured by butter merchants that could they obtain a sufficient quantity of the primest English butter, they could give a price of 1d. or more per lb. in advance of that given for the foreign produce. We are, no doubt, gratified by such an expression of patriotism, but the patriotic sentiment is a dangerous one to rely upon in matters of business, and patriotism only in the few causes a departure from the maxim —Buy in the cheapest and sell in the dearest market.

And now as to the conditions under which a creamery may be established with a fair probability of success. As the price which milk will make at a factory is acceptable or not to a milk producer, according to the price he can obtain for his milk in London or some other large milk consuming centre, it is obvious that the farther we are removed from such centres the more likelihood there is of a creamery succeeding. The establishment must be situated among farms where winter dairying is or will be carried on, since it is of no use, if a permanent trade is to be attracted, to merely arrange for a summer output, when from a factory point of view, when butter is more difficult to make, to handle, and to keep. The summer manufacture of butter, although remunerative in a sense in that milk is at a lower price, requires additional care in the manufacture, and every factory where a summer trade is undertaken, should possess some means of refrigerating and of cold storage. A substantial guarantee must of necessity be obtained from those co-operating in the factory as milk suppliers, that the winter yield of milk must not fall below a a certain minimum. A factory should not, in my opinion, be started unless an average price of 1s. 2d. per lb. all the year round can be assured for the produce. No account must be taken of the separated milk, since it is essential that there should be no responsibility on the factory or its manager concerning the disposal of this. The milk suppliers must undertake—by what arrangements they choose to make between themselves—to remove the whole of this at a price of 1d. to 1¼d. per gallon. From experience it is found that the working expenses of manufacturing, &c., amount to a fraction over 1d. per lb. of butter produced, and if we take into account these items we show for the farmer an average price for the fat of his milk of 5d. per gallon, allowing 2½ gallons of milk average quality (3·5 per cent. of fat) to each pound of butter. For a milk of higher quality payment would be greater, and the following Table is compiled to show the prices paid in an actual establishment for milk :—

Fat in Milk.	Price per 100 lbs.		Price per barn gallon.	
	Summer.	Winter.	Summer.	Winter.
	d.	d.	d.	d.
3·3	52	71	11·44	15·62
3·4	53	72	11·66	15·84
3·5	55	73	12·10	16·06
3·6	56	74	12·32	16·28
3·7	57	75	12·54	16·50
3·8	59	76	12·98	16·72
3·9	60	77	13·20	16·94
4·0	61	78	13·42	17·26

Separated milk charged 1d. per 10 lbs. summer.
1½d. ,, ,, winter.
90 per cent. returned.

The value of the separated milk taken back by the farmer will bring the prices for his whole milk up to 6d. per gallon as an average price for the whole year, which considering that he has his security and regularity of payment, with no deductions and no waste, is a distinctly good financial result for him.

It must of course be remembered that to obtain a sufficient winter supply the winter price for the milk must be pitched a little higher than its actual value and the summer price somewhat lower, otherwise the summer flush will appear to pay the milk supplier better than the winter yield, and the latter may be reduced to the minimum and occasion a disturbance of the supply of butter to the markets. The 1d. and a fraction per lb. already mentioned as the cost of manufacture includes labour, salt, packing, coal, &c., depreciation of machinery, and in a factory taking 1,000 gallons of milk per day the working expenses may be taken as almost 10 per cent. on the returns—this figure including carriage on products but not on the milk which must be brought by the suppliers. As to the cost of erection and furnishing a sum of £700 or £900 would be required, though it might be possible to reduce this if the whole cost of building were not necessary, that is if suitable premises could be obtained, with only a small outlay for necessary alterations, at a yearly rental—the working capital should be sufficient for one month's milk payments at 6d. per gallon, £750, so the total capital required will be about £1,500. An efficient water supply must be secured, and the point I have already referred to concerning drainage must be attended to. Under such conditions and with expert business management and the strictest attention to details on the part of the manager and all the co-operators a creamery may be a success.

That creameries have not already been started in great numbers is unintelligible to a great number of people, but if the conditions I have sketched for the satisfactory working of a factory are in the main true, it is clear that there are not many positions in this country that would satisfy these conditions. There is not sufficient margin in the butter factory or creamery business as a rule to attract outside capital, and when a factory is run as a business concern by capitalists, the result is, unless the promoters have the interest of the farmers at heart, not so satisfactory to the milk suppliers as a co-operative concern. A co-operative creamery is more suitable for a district in the midst of small holdings, where the milk or butter production on each holding is small. If we take the case of Ireland with its 15 million acres farmed mainly in small holdings, there being 483,962 holdings under fifty acres and 410,469 under thirty acres, we see at once that the co-operative factory system has suited the small holders, and similar statistics for Denmark would show a similar result. The returns per acre under a system of co-operative dairying are difficult to obtain accurately, but an average of 150 gallons per acre is certainly above the continental production and possibly about the right figure for our home production—though of this I am not certain—this at 6d. per gallon is £3 5s. per acre, to pay all outgoings. A return quoted in a report by Mr. Gough, of Stockholm, show a return of 64 gallons per acre and a monetary return of 21s. 4d. per acre for Swedish farms supplying a co-operative dairy. Such a return in this country is absolutely useless. The question may well be asked how is it that farmers in Ireland, Denmark, Sweden, France—I will not go into our colonies, where perhaps the conditions are not so simple—can produce milk at so low a cost as 4d. or 5d. per gallon with profit to themselves whilst we in England cannot do the same. My experience, at all events in Denmark, is that the rent question is not the whole reason for the low cost of production; the labour question may to a certain extent but not entirely account for it. Of local and imperial charges on land it was difficult to obtain general information, but I cannot consider that this is the leading factor, and I am therefore led to believe that the system and standard of living of the farmers abroad being so widely different from that at home, is one of the main causes. The position a Danish farmer has to keep up, his personal expenditure and that of his family, the cost of living in such a moderate way as he does, all contribute to the maintenance of his existence on small profits. We in England have seen great changes in the manner of life of farmers even in the last twenty years, and I think in the next generation or two still greater changes will take place, as foreign competition becomes more keen. Far be it from me to say that I wish to see English farmers as Danish farmers, but with the smaller farmers and those not dependent on a speciality, the future points to a narrowing of profits in every department, and therefore a strict economy in all expenditure will have to be observed. Co-operation will be a help, but in this country I am afraid it will be long in becoming established, since there is much opposition in the way of suspicion to be overcome. In the meantime we must strain every nerve to get the cost of production of milk lowered by studying every detail concerned in its manufacture. One of the great difficulties experienced in the dairying districts in the Midlands is the lack of good milkers; this may be overcome in time by the introduction of a good milking machine, which must be inexpensive, easily adjustable, and thorough in its work. The perfection of the mechanical apparatus used in the dairy industry, and the enterprise of manufacturers at home and abroad, indicate that ere long such a machine will appear, and then one of the great difficulties in many dairy farmers' ways will be removed.

Another point to which attention must of necessity be paid if the butter industry of England is to be largely and economically increased, is the productiveness as regards butter of the milking cattle. If we were to average the cows of England on this point of butter-producing, we should find that from 10 to 13 quarts of milk are required for one pound of butter. Selection, breeding, and feeding will have to be employed to bring the average below 10 quarts if profit is desired, for with the present low standard of the whole milk trade it seems as though a cow used for this purpose will not prove economical at the churn. The actual cost of production of a gallon of milk is of course a variable quantity depending on a number of conditions of which the individuality of the animal is the most important, but I think, under average conditions, the cost is not much below 3¼d.-3¾d. per gallon. Assuming milk to be sold at an average price over the whole year of 6d. per gallon, we get, with a yield of 400 gallons, a profit of something over £3 per cow. Such a cow of average quality, giving 1 lb. of butter to 2½ gallons of milk, will yield 160 lbs. of butter in the year. If we can increase the butter ratio without diminishing the yield of milk—as I believe is possible by careful selection—so that 2 gallons yield 1 lb. of butter, we increase our output by 40 lbs., with a corresponding increase of profits. A butter cow should therefore be of a different type from a milk or cheese cow, and if we have to sacrifice some of her beef-producing value when dry or barren, we must consider whether such a result is not in the end profitable. Piece work is admittedly beneficial in other processes of production, and if in the past a general utility cow for milk and beef production in times of higher prices has been sufficient, it may be that in the future we shall have to use different types of animals for the two purposes. Few farmers know the total yield of the cows per annum, so that whether a cow is a profit or a loss is more or less uncertain—fewer know or care about the composition, as regards fat, of their milk, and fewer still have worked out the butter ratio for individual cows or herds with a view to improving it. I think this is a point on which experiments by a central body might well be undertaken—whether improvement in the butter ratio of a herd can be obtained, since our object is to lower the cost of production not so much of milk as milk, but of butter. We know that we can by a system of forcing largely increase the yield of milk (with a certain amount of injury to the stock); we also know the small or comparatively small influence of food on quality, the individuality of the cow being the predominant factor in the production of quality. We have acquired very considerable technical skill in butter-making, thanks to the efforts in the first instance of such associations as the British Dairy Farmers' Association, and subsequently to county councils, can we not work backwards and try and decrease the cost of production of butter by an enquiry into the best character of animal for the work? The statistics given by Mr. Hall in his evidence before the Royal Commission is exceedingly suggestive on this point and is well worth careful perusal. His experience with Jerseys is extraordinarily good, and he is a butter maker in the heart of a cheese-making country. Another point to which he calls attention in butter-making, and a point which has often occurred to me in my experience, is the churnability of the fat in different milks, a factor depending, in my opinion, on the breed of cow, her age and feeding. I merely mention these points as indicating lines on which inquiry might profitably be held, as exact knowledge on these points may throw much light on this butter-making question.

Under the present conditions then of milk production in England I am of opinion that a universal factory system would not be a financial success or improve the condition of English agriculture. Under special conditions and catering for a high class trade a factory may be successful, but only a limited number of such factories can be established, and then a small profit per pound on a large output is all that can be expected. The whole milk trade of England, absorbing as it does nearly one-half of the milk produced in the country, is on the increase and requires the most careful supervision to provide against adulteration. As long as milk can be disposed of whole under satisfactory conditions of trading, whole milk production for sale will be the chief dairy industry, and it is only that part which cannot be disposed of as whole milk that will find its way to butter factories.

Another point on which the most careful supervision is required is that of the adulteration of butter. I do not consider the regulations for the sale of margarine perfected in this country or abroad. Margarine, at all events in my opinion, should be sold uncoloured, and never under the same roof as butter. We all know when the price of butter is high temporarily the enormous increase in the sale of butter substitutes, and we are not absolutely sure that our foreign imports are without suspicion in the matter of adulteration. As an instance of how the margarine law is evaded in Denmark, I may quote a personal experience. The law, as is probably known to my hearers, forbids margarine to be sold coloured beyond a certain shade of yellow. This regulation is acted upon, but in the shops selling margarine there is given with every pound of margarine sold a small tube of annatto, a colouring matter, so that the purchaser can perpetrate the colouring himself at home, and this is done largely in the case of hotels and large boarding establishments.

I have not dealt with the subject of cheese, as the question is not quite on the same lines as that of butter, but cheese factories in this country, although having their ups and downs, have been on the whole successful. As I have already stated, the primest qualities of cheese or butter will never be made in a factory, creamery, or cheesery from mixed milk, and large farmers who are cheese or butter makers of known repute will be losers by adopting the factory system. Co-operation will improve the position of the small cheese makers, as it will of the small butter makers, but the co-operation must be gradually introduced by the establishment of the depôts I have suggested.

I do not wish to throw cold water on the well-meant attempt of many who advocate the imitation of the foreigner in his methods, wholesale and at once. I merely wish to record my opinion for what it is worth, and I may be wrong in my attempt to postpone the practical establishment of factories wholesale until the situation has been more fully discussed and understood. We are an enormous food-consuming nation; in no other department save that of whole milk do we, or can we, I say, produce all we consume, and the position we as food-producing farmers ought to take up, is to produce the best and market it in the best way, and let the lower and cheaper qualities be produced by the foreigner and imported. There is plenty of scope for enterprise and improvement both in our products and our methods of marketing. To these points attention and organisation should be first devoted.

DISCUSSION.

Mr. **George Barham** said they were much indebted to Mr. Dunstan for this very able paper. He had rather expected that an attack would have been made on the middleman, which was always amusing, and he should have enjoyed taking up the defensive. There was no doubt that the low price of dairy produce was a serious difficulty to the agriculturist, and it did not seem to him that the author had quite found a remedy. But it was not only the low price of dairy produce, but of everything else which caused the evil. As had been said, the style of living in Denmark was very different from that in England, but even if an English farmer could live on air, it would not put him straight. The Danish farmer had advantages and disadvantages; one very important advantage was that he got his labour very cheap. He could get a good labourer who would work from daylight to dark (which in the summer was nearly 20 hours) for a kroner a day or a little more (about 1s. 1d.), whilst his labourers in Sussex would not work longer than nine hours a day, and they got 2s. 6d., and were dissatisfied if they were asked to stay an hour longer at haymaking. How an English farmer could produce his goods at the same price as the foreigner under those circumstances he could not imagine. He doubted whether co-operation would meet the difficulty. The most useful man in the world was the middleman, and he did not think they could do without him. If the sale of English produce were taken out of his hands, it would only lead to his importing more from abroad, and further lowering English prices. One of the favourite remedies was the establishment of factories in certain localities for dealing with what was called surplus produce. When he was young it was the custom of the dairy trade to buy the whole of the milk the cows produced, but more recently it had become the fashion for the dairymen to buy what they required, and leave the farmer to deal with the surplus, and this it was suggested should be taken by these factories. But first of all there would be the expense of erecting the factories and purchasing the machinery required; but the great difficulty, to his mind, was that of maintaining the staff. If you wanted good butter and cheese you must have the ablest men to make it, and these men would only be occupied three or four days a month, and perhaps partially occupied the remainder of the time; their wages, therefore, would be a considerable item, and more than make up for the saving effected in other ways. He thought if enough were to be done in this way they should adopt the system practised in Paris fifteen or twenty years ago, under which the large dairymen had factories in different parts of the country where they purchased the milk, sending what was required to Paris and making the remainder into butter or cheese. That was putting the burden on the right shoulders. The business of the farmer was to produce milk, and it should be the duty of someone else to sell it. It was so in all large and prosperous undertakings. The manufacturer produced his goods and they were taken off his hands by the merchant or dealer; he did not attempt to sell them himself.

Mr. **Clare Sewell Read** said the author had put before them a most excellent paper, and had treated the question in a thoroughly practical way. The dairy industry, he feared, was likely to suffer as much from the enthusiasm of theorists as from the conservatism of farmers. Coming from a country where there were very few cows he could not pretend to know much about dairying, which was quite a secondary consideration in an arable district like Norfolk, and the success which had attended the system introduced by Mr. Plunkett in Ireland was not likely to be attained in the arable districts of East Anglia. Mr. Plunkett had told them that in order for a factory to be successful it must have the milk of 500 cows within a radius of 2½ miles, but in East Anglia you would hardly get that number in a radius of ten miles, which, of course, made all the difference. He agreed with Mr. Barham that the main reason why the foreigner could undersell the English farmer, was the low cost of labour. It was not only the labour he hired, but that which he had at his own disposal, because the women and children abroad worked very much harder than our farmers' wives and children did. In his part of the world, it was a common saying that the only way for a small farmer to succeed, was to do the work of two labourers and to live at the expense of one. Whether that was to be the outcome of English agriculture, he did not know, but, personally, he should rebel against it; fortunately for him, he had now almost retired from farming. It was very justly remarked in the paper that the practice of selling whole milk off the farm would lead to its deterioration, unless a sufficient quantity of manure were brought back to the land; but, generally speaking, in order to maintain a winter supply of milk, large quantities of artificial food were given to the cows. The fact that you could foretell the price of butter, within a week or two, by looking at the almanac, was rather remarkable; but it was explained when one remembered that when a cow was turned out to grass in the spring, she immediately increased her output of milk the first week. This led to an enormous quantity of butter being thrust on the market, and it was a curious fact that you could not get English farmers, as a rule, when they had this sudden overplus, to salt it, and keep it until they could sell it at much advantage in the autumn and winter. He thought something might be done by establishing factories in certain districts, and hoped at least that the attempt would be made; but if the result of Mr. Plunkett's admirable system in Ireland had only been to give the farmer, with his skim milk, about ½d. a pint, he did not think that was the way to make a fortune by agriculture.

Dr. VOELCKER said he must add his tribute to the high character of this paper. The author had thoroughly defined the position of the farmer, neither adopting the exaggerated views of some, or the over sanguine views of others, but stating the case clearly and fairly. They all must acknowledge that the time had come when the farmer must look to what had been called the smaller items, if he was to make any success at all of what would be always a poor business, but which had, and always would have, certain attractions. The question was, how far would co-operation be of advantage in dairy-farming; and this paper gave not only a timely warning, but useful encouragement to those in certain favoured districts. It rightly held out no great chance of success for the establishment of creameries throughout the country as a whole, because selling the whole milk must continue to be the backbone of the industry where the farmer was so situated that he could command a good market. The conditions under which co-operation might be successful were adverted to in various places, but he did not know that they were anywhere put in one concise sentence, unless it were where the author insisted on the necessity for business capacity. That was what the farmer would have to learn. In fact, the closing words of the paper contained the gist of the remedy; there must be an improvement both in the quality of the product and in the method of marketing. Considering the competition of foreign countries they had to face this question—were they going to see the British farmer reduced to the condition in which the agriculturists of other countries were? He had seen a good deal of those conditions abroad, and had been much struck by what Mr. Read had said, that if they wished to compete thoroughly with the foreigner they must be content to live as he did. He thought that there would be a hard struggle before that state of things was accepted, and he had hopes that by the reading of such papers as this, by superior business capacity and methods of organisation, and the production of better articles, English farmers would still be able to live as they did now, and yet keep ahead of other nations. The great advantage of factories was that they turned out, not the best article, but a uniform article. There lay the great difficulty which any dairy farmer who had not a large quantity of produce to deal with must always experience in getting a footing on any market. If the butter was made one way one day and another way the next, it was impossible to get a good price for it; a variable article, although good sometimes, was always beaten out of the market by one which was of uniform quality, though on the whole inferior. It was well known that any person in the country who made good butter, could, amongst the private residents, get a good price for it, and command a ready sale; and in that direction there was hope. Mr. Read had referred to the need for feeding the cattle properly. The middleman, as a rule, by the aid of tests which had come in to help him, and in a certain degree to destroy the work of the analytical chemist, was able to see that the farmer fed his cattle fairly well. Taking it all round it must be said in favour of the retailers, that the quality of milk supplied in London had been distinctly improved and, as a rule, the public got a genuine article. This experience also led him to the conclusion that farmers were more careful about the feeding of their cattle, and were not satisfied to produce any article to which the name of milk could be applied. Mr. Dunstan, with the aid of the noble Chairman, had done a very great work by showing farmers, by practical experience, what could be done by means of limited co-operation. It had been a great pleasure to him to visit the Midland Dairy Institute, presided over by Mr. Dunstan, and to see there the advances which had been made in scientific and practical cheesemaking. Questions had there been solved which were quite a revelation even to himself, and some ideas which had been generally held had been entirely dissipated. For instance, it had been held that certain cheeses could only be made in certain parts of the country, where it was supposed that certain bacteria or microbes were floating about, which gave them a certain character, and again that on certain pastures you could not make cheese properly. Mr. Dunstan had done a great deal to dissipate these bogies, and any one who would visit the Midland Dairy Institute might see made there, by a proper combination of science and practical skill, cheeses of all kinds, and they were marketed and sold in a practical way too. In fact the Institute was a remarkable instance of what could be done by a combination of scientific knowledge, business capacity, and attention to details.

The CHAIRMAN said it had given him great pleasure to take the chair on that occasion, as he was quite certain from his knowledge of Mr. Dunstan that he would give them a paper which was not only scientific but thoroughly practical. As director of the institute, to which Dr. Voelcker had alluded, in Nottinghamshire Mr. Dunstan had shown the farmers that he could not only tell them what he had learned scientifically, but could explain the reasons for their practical methods. He (the Chairman) had taken a great interest in the institute, and had done what he could to facilitate its operations, when it was founded by the four counties of Notts, Derby, Leicester, and Lincoln, with money devoted to technical education. Beyond the actual dairy education, which was the first thing considered, those who had interested themselves in it had gained some practical knowledge of the points which had been mainly referred to in the paper, viz., how far a co-operative factory for farmers could be made to pay. He had been much struck by what Mr. Dunstan had said on this point, and he thought the pith of his experience might be found in the remark that it was no use starting such a factory unless you were satisfied that you could get something like 1s. 2d. a pound for the produce. That, of course, must be borne in mind, but that was no reason why they should do nothing. He had shown how, at all events, they might begin in a small way in suitable places. A small depot to which the milk might be brought, and where the butter might be made by one hand, and of uniform quality, might be useful in some districts, as it would ensure a regular quality and regular price. He looked, however, with more hope to the establishment of grading factories, which would bring the butter from the farmers, sample it, and grade it in qualities which would have a recognised price. He had been much interested in Mr. Barham's remarks, though he did seem a little disappointed that no attack was made on the middleman. He would not make any such attack, for no doubt the middleman was most useful in connection with agriculture, but he might be still more useful if the farmers could by any system of co-operation become a little less at his mercy than they sometimes were at present. Mr. Read's remarks and Dr. Voelcker's were also very pertinent and interesting, and he thought the result was that the more this question was looked at, the more convinced they would become that it could not be solved by simply copying other nations, but any system which had uselul features about it, would have to be adapted to the conditions under which business was carried on in this country, and in this respect the present paper was exceedingly valuable.

Mr. DUNSTAN, in reply, said when he was in Denmark he asked one of the greatest authorities there to what county in England he would compare Denmark, and his answer was unhesitatingly, Norfolk—both for the character and extent of its grass lands; and yet Denmark had found it its best policy to go in for dairying. He must tender his thanks to the Chairman not only for his liberality in all matters connected with agriculture in Nottingham and the neighbouring countries, but especially for his kindness in coming all the way from Nottingham to take the chair that evening.

The CHAIRMAN then proposed a vote of thanks to Mr. Dunstan, which was carried unanimously.

Miscellaneous.

VENICE FINE ART EXHIBITION.

The second International Fine Art Exhibition will be held at Venice from April 22nd to October 22nd next, and will occupy the same building as that used for the first exhibition. Five additional halls have been expressly built and added to those of 1895. Consul Chapman says that the exhibition promises to be a most attractive one, as works of art not only from European, but also from Asiatic and American artists, will be on view. The works of artists not invited to exhibit will be subjected to the verdict of an international jury, who will only select a limited number. Venetian or Italian artists residing in Venice will not be invited. No artist will be allowed to exhibit more than two works, except in special cases to be decided by the Committee. No work already exhibited in Italy will be admitted. The aggregate amount of the prizes is 40,000 lire (£1,600). The work of preparation is nearly completed, and about two hundred foreign artists have sent in their names as exhibitors. The English committee of patronage is composed of the following artists: — Mr. Alma Tadema, Sir E. Burne Jones, Professor H. Herkomer, and Mr. W. G. Orchardson. The President of the Exhibition is Count Filippo Grimani, Syndic of Venice. The managing committee is under the presidency of Professor Pompeo Molmenti. The secretary is Professor Fradeletto, to whom all applications should be addressed at the Municipality. This exhibition, the inauguration of which is to be honoured by the presence of their Royal Highnesses the Prince and Princess of Naples, is expected to prove a most interesting collection of modern artistic pictures and sculpture from all parts of the world.

RAILROAD DEVELOPMENT IN JAPAN.

The total length of railways in Japan, which in 1872 amounted to only 18 miles, increased in 1880 to 97; in 1885, to 352; in 1890, to 1,362; and at the end of 1895, the latest year for which returns are available, to 2,243 miles. When railways were first started in Japan it was generally supposed they would not pay, because the people were not much given to travelling. A greater mistake could hardly have been made, because as a matter of fact, the reverse has proved to be the case. Not only in large cities, but in rural districts the railway carriages are always crowded with people, and vast numbers appear to be always travelling. As regards the work of railway construction which is really in hand in Japan, by way of preliminary to doubling the Tokaido trunk line, the authorities are now laying two new lines between Shimbashi and Shinagawa in the city of Tokyo. The new lines will be laid close to the shore, and will extend from Shinsenza in the Shiba district of Tokyo, to the central station that will be built within the palace grounds. Between Shinsenza and the street clase by the Tokyo Hotel, an elevated railway is to be constructed; the surveying alone will take about a year, and the period assigned for the completion of the central station is seven years. Seven Government lines are to be completed by the spring of 1903. The mileage of these projected lines is as follows:—Fukushima-Aomori, 298 miles; Tsuraga-Toyama, 123; Hachioji-Nagoya, 223; Umedaichi-Kure, 12; Shinoroi-Shiojui, 41; Yashiro-Kogoshima, 91, and Himeji-Sakai, 135 iles, making a total of 925 miles. In addition to these Government lines, a number of private companies are interested in the construction of lines of greater or less length. Something of the railroad industry may be imagined from the fact that the Railway Council at a recent session recommended that charters be granted to nineteen companies which desired to construct railroads, and a few months earlier the Council made a similar recommendation in the case of eight other companies.

COCOANUT CULTIVATION IN SAMOA.

The single exportable staple for which Samoa is eminently adapted, and the one upon which all its business at present rests, is the cocoanut (*Cocos nucifera*). It is to Samoa what cotton and corn are to the United States; all that grain, meat, and wool are to the Australian Colonies. The export of the copra alone, save with trifling and inappreciable exception, represents the entire agricultural productive capacity of Samoa, and through this source all the money that trade and commerce bring into the islands finds its way. The United States Consul-General at Apia says that if the cocoanut crop were an absolute failure for a single year, the entire export of the kingdom would not amount to more than £1,200, and this illustration will adequately represent the prime importance of this single article to the country and its needs. The accepted method is to plant the cocoanuts in rows forty feet apart, setting the trees thirty feet in the row. The cocoanut loves the sunshine and free circulation of the air, and to flourish in perfection it should stand on the outer verge of the shore, its roots striking into the sea water, its branches or palms tossing in the breeze. The lowlands of the beach in the Samoan Islands are more or less covered with the groves, while on the mountains or highlands no tree is found. The smaller size of the trees and the poorer yield is plainly to be noticed on lands at an elevation of from 400 to 600 feet situated at as short a distance as 2½ and 3 miles from the shore. Standing immediately on the beach the tree inclines outward over the water; growing inland it points by its leaning in the most direct way to the sea. The nuts ripen throughout the year, hanging in clusters close in and around the stems of the palm branches, which spread about on all sides, and reach upward from the clustered head forming the top of the tree. The height of the trees is from 30 to 80 feet. The trees come into bearing at the sixth year on suitable soil, and are believed to reach the full limit of production at from 15 to 20 years of age. Many groves known to be 30 and 40 years of age are now bearing in undiminished abundance, and they so continue to do to a great age. Persons who profess to be able to determine the age of trees by the marks left on the bark where the branches have successively fallen, estimate in this way that many still vigorous trees are 70 and 80 years of age. The habit of the cocoanut to reach out over the water seems to be a provision of nature for its propagation and distribution. The nuts falling into the sea will float for weeks in the bitterly brackish waters of the tropic seas without injury to the germinating quality. Once thrown upon the warm sands of a beach, or tossed by a wave upon a reef above the surface, it soon puts forth its palm from the smaller end, while from the round and larger end the tender roots strike into the soil or decayed coral, as the case may be. Many lagoons which have risen within living memory, and which for years remained without sign of vegetation, are now covered with the cocoanut, although hundreds of miles from other islands. The value of the cocoa-nut is not confined to the single export product, copra. The tree and its products are devoted to many uses. The wood in the green state is very porous and spongy, having consequently a great degree of resistance to rifle shot. In the native wars in the past it was much employed in the building of defensive works. When thoroughly seasoned it lasts for a long time underground, and is valuable for all purposes for which posts are employed. The oil enters in many forms into the domestic uses of the natives. It forms the basis of all their liniments and emollients in their pharmacopæia. The nut is one of the standard articles of diet. Breadfruit, taro, bananas, and cocoanuts form the staple articles of food, ranking in importance in the order mentioned. The fibre furnishes all the sennet, or braided twine and rope, for all uses. The leaves of the great branches, which dry rapidly, are used for kindling, for torches, and light and firing for the household. It is generally estimated that an acre of land should yield, when the trees have reached the period of full bearing, about half a ton of commercial copra. Copra "making" is at best a slow and laborious process, and is effected as the nuts ripen, from about the middle of April till the middle of October or early part of November —that is, during the dry season, but the making is more active in July, August, and September. A boy or man, with a piece of sennet about eighteen inches in length, looped on either foot, will climb the slender, swaying tree with as much ease and rapidity as if it were a ladder. The notches or corrugated surface of the bark catches the bit of sennet between the feet, while the weight of the body pressing downward, clamps as it were the hollow of the feet firmly on either side of the trunk. By this means the tree is ascended by a series of jumps. The climber with a big knife cuts away the matured nuts, which cluster close about the butts of the branches. As they fall they are gathered into piles about the base of the trees. On the plantations they are gathered into baskets slung on donkeys, or swung on poles borne by two men, to be finally piled into great heaps near the copra shed. The nuts are not husked, the thick outer husk having become hard and brown, like wood. They are dextrously split in two by an axe, and the hard white flesh is cut out with a large knife. Nothing remains but to spread it on mats or boards in the sun. When cured it is thrown into a heap in the shed, where it remains until placed in sacks to be carried out to a small boat, which in turn transfers it to the small schooner or cutter lying in deep water, and from this in turn it is again taken to be stored elsewhere, or transferred to the deep sea vessel for its final voyage. Copra yields perhaps a greater per-centage of oil than any other of the great oil-producing staples under the modern process, whereby it is mixed with water, heated, and subjected to two pressings, giving as high as 62 and 64 per cent. of pure oil. The cocoanut crop of 1894 was by far the largest ever known in the islands, and the extent of the increase is illustrated by the fact that while the export of copra in 1891 amounted to 4,842 tons, in 1892 to 4,871 tons, and in 1893 to 4,602 tons, it rose in 1894 to 6,214 tons, an increase of 1,612 tons over the year before—an increase of about 33 per cent. over the years 1891 and 1892. In the trading stations in Samoa enormous profits are made in the copra trade.

HAT MAKING IN ITALY.

Hat making is an important industry in Italy, both for felt and straw hats. Monza, near Milan, is the centre of the felt hat industry, and there are many large establishments in that town. Felt hats are made of rabbits' wool and hair, but chiefly of the former material. The special machinery employed is both simple and ingenious, and is made in Monza. The fine dressed wool is blown with a strong fine spray of steam and boiling water on to a heated revolving conical metal form, and in a very short space of time a paste or coating of felt is formed. This felt is then dried, removed, and given the desired shape. One single establishment in Monza driven by a 400 horse-power engine, employs over 500 hands, and turns out 4,000 to 5,000 finished, and 10,000 to 12,000 unfinished hats per diem, besides some 3,000 hair hats. Unfinished hats are neither lined nor trimmed, and are sold in Italy to avoid duty when exported to foreign countries. About one-half of the hands employed are women, who earn at piecework about 1·25 lira per diem (lira = $9\frac{6}{10}$d.). Men earn about 2·50 lira per diem. The number of hours actual work is 10. About 30 per cent. of the production is exported. South America, France, and Switzerland are the chief markets. There is also a trade with London for supplying British Colonies. There are branch factories at Barcelona and at Buenos Ayres, which have been established to avoid payment of duties. The value of felt hats exported is about £200,000 per annum. Straw hats and straw plaits for hats are chiefly made in Florence and the neighbourhood. The plaits are sown together, pressed and shaped in large establishments, whilst the plaits are made by women in the villages, who are paid so much a metre for plaiting according to quality. The price paid for the plaits are very low, and not long since there was a strike among the plaiters. The industry has lost much of, at least its relative former importance. The decline in the trade is attributed to the decreased demand for hats made of the finer qualities of straw, and to foreign competition in the production of coarse plaits. The best markets are in the tropics, and particularly in South America. The total value of the exports, including both hats and plaits, still exceeds £500,000 per annum.

Correspondence.

BRITISH COLONIES OF AUSTRALASIA.

I have been informed that some persons believed that my phrase—"He only wished that the Government, in connection with recognised societies," &c. [see p. 397 *ante*]—meant the West Australian Government. I am sure the context farther on, viz., "would take measures for *sending* out," ought to have shown even a casual reader that I could only have referred to our own home Government.

G. G. MACWILLIAM.

General Notes.

VIENNA AGRICULTURAL EXHIBITION.—An exhibition of agricultural and forest products organised by the Imperial and Royal Agricultural Society of Vienna, will be held in that city from the 7th May to 9th October, 1898. This exhibition will be international so far as regards the articles comprised in the following sections:—Machinery and tools used in agriculture and forestry; articles used in the dairying industry; expedients and perfected systems employed in rural economy; the veterinary art; improved system of buildings for farm and agricultural purposes; system of agricultural and forest education.

COMMERCIAL TRAVELLERS IN SWITZERLAND.—Some statistics have recently appeared in the *Schweizerisches Handelsamtsblatt* with reference to the number of licenses issued by the Swiss authorities to commercial travellers doing business in the country. It appears from these statistics that the number of licenses granted in 1896 to commercial travellers amounted to 19,667, as compared with 19,118 in 1895 and 18,653 in 1894. Among these travellers

15,171 represented Swiss houses, while 4,496 were engaged on account of foreign firms as follows:—German, 2,952; French, 1,051; Italian, 235; Austrian, 129; English, 50; Belgian, 42; Spanish, 18; Dutch, 14; North American, 4. The provision trade appears to employ the largest number of travellers in Switzerland, 6,735 altogether in 1896; the wine trade 3,159, and the textile trade comes third with 4,633 travellers.

SPANISH BULL-FIGHTS.—The United States Consul at Barcelona says that, "During the latest bull-fight season, from April 5th to October 20th, 1896, there were 478 bull-fights in Spain, and 1,218 bulls, valued at £60,000, and 5,730 horses, valued at £40,000, were killed. The number of matadores was 23, and they were paid for their services in all 1,329,000 pesetas, or £53,860. The less-renowned matadores received from £60 to £80 for each fight in which they took part, while the most renowned received from £100 to £170. The famous Guerrita appeared in 68 fights, killed 174 bulls, and received in all £10,250; Bombita fought 43 times, killed 112 bulls, and was paid £4,250; Mazzantini was in the ring 29 times, killed 68 bulls, and made £4,350. They were the favourite matadores. Some only appeared in the ring once or twice, and they were those who received the smallest remuneration. It cannot be truthfully said," remarks the Consul, "that the interest in bull-fighting is diminishing in Spain, on the contrary, it seems more intense than ever."

ITALIAN CORAL.—The coral industry, which is of considerable importance in Italy from the maritime point of view, also employs both capital and labour for working up the raw material procured by the fishermen. Leghorn and Naples, and particularly the former, are the great centres of the coral-working industry. There are no complicated processes, it being only necessary to select from the rough material the better qualities according to colour, and the better portions of such qualities, and to form them into beads of various shapes to suit different markets. The work is almost entirely done by girls, who saw, turn, file and polish the raw material. Prices vary greatly according to the shades of colour and to the size of bead of uniform shade which can be produced. "Of late years the average price has fallen considerably," says Mr. FitzGerald Law, Commercial Attaché, "owing to the increased production of what are considered inferior qualities, but the price of the best-coloured coral remains very high, reaching exceptionally to as much as £12 per ounce." The exports of coral, rough and worked, amounted in 1895 to somewhat over £1,000,000 sterling. About 60 per cent. of the exportation is to British India, and the demand for the African market is said to be most promising for the future.

HEMP CULTIVATION IN BOLOGNA.—One of the most important agricultural products of the provinces of Bologna and Ferrara is hemp (*Cannabis Sativa*). Bologna hemp is generally manufactured into yarns and canvas. The Ferrara quality is principally used for rope making. The former is a finer fibre than the latter, but not so strong; they are both however held in high esteem in textile centres abroad, according to the United States Consular Agent at Bologna, chiefly in Germany, France and Spain. The cultivation of hemp has greatly developed in Bologna and Ferrara, owing to the favourable conditions of the climate and soil, which are not easily found in other countries. Hemp may be cultivated between the equator and 60° latitude. Chemically the land must be siliceous, argillaceous, calcareous and rich in azote. Physically it must be soft, fresh and deep. In addition the land must be abundantly manured. Sowing generally takes place in the spring, owing to the necessity of a temperature of 46·4° Fahrenheit, and a moderate degree of humidity. It is preferable to sow by machine, this system saving seed, and the sowing being much more regular. The land must be previously deeply ploughed. After sowing the land requires to be hoed, and much other work is necessary, such as the extirpation of weeds, &c., in order to obtain an abundant crop. The crop ripens in August or September according to the weather. It consists of stalks about three metres long. These stalks are placed in bundles and put into ponds expressly constructed, where they remain about a week. They are then dried and scutched by means of a complicated process, which produces the fibre ready for market.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 12...Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. George Reid, "Sanitary Appliances."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. H. Heathcote Statham, "The New Government Offices Scheme."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Mr. Campbell Swinton, "Some Recent Investigations in X Ray work."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Dr. Schofield, "The Scope of Mind."

TUESDAY, APRIL 13...Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., Discussion on Messrs. David Hay's and Maurice Fitzmaurice's Papers, "The Blackwall Tunnel."

Photographic, 12, Hanover-square, W., 8 p.m. Mr. C. F. Townsend, "Colour Measurement in Photography."

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Sir Donald Smith, "Western Canada."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m.

THURSDAY, APRIL 15...Linnean, Burlington-house, W., 8 p.m. 1. Mr. A. A. Walker, "Some New Irish Crustacea." 2. Messrs. W. and G. S. West "Desmids from Singapore." Exhibition of Plants collected during Two Years' Residence in Franz Josef Land, by Mr. H. Fisher.

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FRIDAY, APRIL 16, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The fourth meeting of the Congrès International de l'Enseignement Technique will be held this year in London, commencing on the 15th of June next, at the invitation of the Society of Arts, and of the Worshipful Companies of Drapers, Fishmongers, Goldsmiths, Merchant Taylors, and Clothworkers.

The Congress will be opened at 11 o'clock, on the 15th of June, by an address from the President, the Duke of Devonshire, K.G.

The subjects for discussion at the Congress will include :—

Technical Education :—

1. Advanced Instruction. Polytechnics, Universities, Colleges.
2. Secondary Instruction. Higher Technical Schools ; Secondary and Intermediate Schools ; Evening Schools.

Commercial Education :—

1. Advanced Instruction. Colleges ; High Schools and Institutes of Commerce.
2. Secondary Instruction. Commercial Schools ; High Schools ; Classes for Adults.

It is not proposed to deal with elementary Technical or Commercial Education. The education of both sexes will be included. Further information will be issued at a later date.

The Executive Committee will be glad to receive offers of papers coming within the scope of the subject as above defined. The papers must be in the hands of the Secretary not later than the 29th May.

The papers will be printed and distributed at the meetings. They may be in French, German, or English, and speakers may make use of any of these languages.

All communications relating to the business of the Congress should be addressed to the Secretary, Society of Arts, John-street, Adelphi, London, W.C.

JOURNAL ADVERTISEMENTS.

From the present date all arrangements connected with the advertisements in the Society of Arts *Journal* will be in the hands of Messrs. Street Brothers, 164, Piccadily, W. All communications, therefore, referring to advertisements should be addressed to Messrs. Street.

Proceedings of the Society.

INDIAN SECTION.

Thursday, April 1st; Field-Marshal Sir Donald M. Stewart, Bart., G.C.B., G.C.S.I., in the chair.

The Chairman stated that Mr. O'Dwyer having returned to India, the paper would be read by the Secretary of the Section.

A VISIT TO RUSSIAN CENTRAL ASIA.

By Michael Francis O'Dwyer, I.C.S.,
Director of Land Records and Agriculture, Punjab.

The tribes and cities of Central Asia—Merv, Bokhara, Samarkand, Tashkent—must always exercise a peculiar fascination for the British traveller, especially if he happens to be connected with India. They appeal alike to the ethnographic, the archæological, the historical, and the political instincts, and offer a rich mine—which has not yet been fully explored—for antiquarian and historical research. The conquest of the Khanates by Russia within the last thirty years has, in a sense, added to their interest as offering another example, which may usefully be compared with India, of the result of the impact of new forces—physical, mental, and moral—on the ancient and stereotyped Mohammedan semi-civilisation of the East, and affording us a means of testing the success of the assimilative capacity of the Russian conquerors.

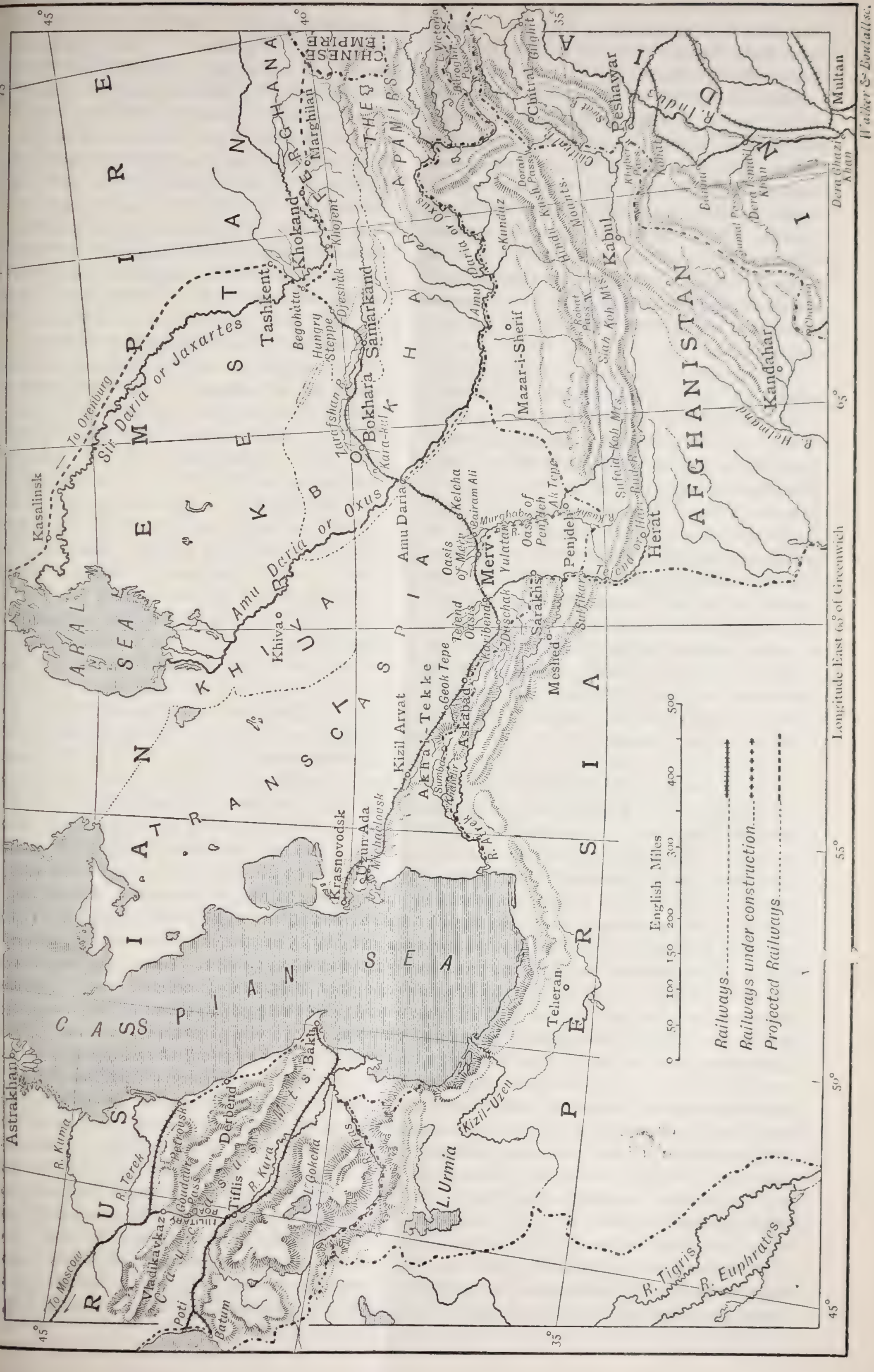
Hence it was that after spending a winter in Moscow, and acquiring some knowledge of the vernacular, I determined, in company with two friends, also members of the Indian Civil Service, to take advantage of the thaw—always an unpleasant time in Russia proper—to pay a flying visit to Central Asia, returning to Moscow in time for the Coronation. Our object was to get as far as Samarkand—seeing Merv and Bokhara on the way—by rail; push on to Tashkent, and, if possible, to Khokand, the capital of the rich and rapidly-developing province of Ferghana, by road; and return from Khokand direct to Samarkand, and so back to the Caspian by the same route.

Armed with the necessary permission from the Russian Foreign Office, which is indispensable for all British subjects entering Russian Central Asia, and which we finally obtained, after many futile applications in Russia, through the good offices of the India Office in London, we succeeded in carrying out our plan, with the exception of the visit to Khokand. This we were obliged to abandon, owing to press of time, and the impossible state of the roads, after the abnormal spring rains. Our trip, therefore, practically covered the ground traversed by Mr. Curzon in 1889, and so admirably and faithfully described by him in his "Russia in Central Asia," but was very brief and hurried, as we were back in Baku, on the west shore of the Caspian, within three weeks of leaving it.

We had letters of introduction to some of the Russian officials, including General Rostofftreff, the Governor of Samarkand, who was most kind and courteous in putting us in the way of acquiring information, and were received everywhere with courtesy. The insatiable curiosity of our Russian fellow-travellers, whom it was difficult to convince that we had no ulterior motive beyond ordinary curiosity and love of travel, was at times slightly inconvenient. The fact that we were connected with India now and then seemed to give rise to the suspicion that we came to spy out the land, or with some political object. But the Russians are invariably civil and pleasant travelling-companions, and once we succeeded in satisfying them that we were nothing but what we professed to be, we found them willing enough to talk freely and tell us what they could of the country. The great difficulty was to get really precise information. Your Russian, though an eloquent talker, is not, as a rule, an accurate thinker. Hence, two different informants would give completely conflicting accounts, say, of the Customs arrangements with Bokhara, or the mode of assessing and collecting the land revenue. We found that Jew money-lenders, Armenian merchants, Kirghiz traders (whom one fell in with on the road), even the Hindu immigrants from Shikarpur, Sind, Amritsar, and Peshawar (whom we met in Samarkand and Bokhara, and who heartily welcomed us as fellow subjects of the Queen-Empress), knew much more about these matters than the average Russian. The following observations must, therefore, not be understood to bear the fiat of official authority, being based largely on the above non-official sources, and on persona observation. For much of the information regarding Transcaspia, I am indebted to the courtesy of Col. Alikhanoff—the hero of Penjdeh—now Police Prefect in Tiflis, but formerly Governor of Merv; while the Governor of Samarkand supplied us with many interesting facts regarding the civil administration of Turkestan.

Leaving Moscow at 11.30 on the morning of the 10th April, winter was still lingering, and the snow was still a couple of feet deep on the ground, and halting for a day at Rostoff on the Don, we arrived at Petrovsk on the Caspian, 1,350 miles from Moscow, at 4 a.m. on the 14th, and found ourselves in the bright warm summer of the South. The mail steamer, which should have arrived that morning, and taken us direct across to Uzun Ada, had been detained by the ice off Astrakhan, and as there was no certainty of its early arrival, we decided to run down to Baku by the Kavkaz and Mercury coasting steamer, on the chance of catching another steamer of the same company crossing to Uzun Ada. Leaving at 3 p.m., we passed Derbend (where the Caucasus range comes down to the Caspian) at 10 p.m., and keeping in view of the coast all the time, we arrived at Baku at 3 p.m. next day. Luckily we found a small steamer ready to start for Uzun Ada that evening, and employed the interval in seeing something of Baku.

The only absolutely safe and certain harbourage on the west coast of the Caspian—except Astrakhan, which is closed by ice for at least two or three months—Baku, besides its world-famed kerosene industry, is the most important commercial station on the Caspian, and is strategically important as a main link in the chain of communications through which the Asiatic or Transcaspian provinces of Russia draw their supplies of men and military stores from the Caucasus and European Russia. At present the only land communication with Russia is by the railway to Tiflis, and thence across the Caucasus by the famous Georgian military road to the railway at Vladikavkaz, a distance of 135 miles. Communications by this road—a magnificent piece of engineering, which winds its way over several passes from 6,000 to 8,000 feet above the sea—is, however, often interrupted during the winter months by snowdrifts and avalanches. When we crossed it on the 8th May, on our return journey, the passage through the Pass of Goudaur, at the summit, was literally through walls of snow. It is,



Walker & Boutall sc.

therefore, now proposed to link Baku direct with the Russian Cis-Caucasus Railway system by two routes (1) by continuing the present line to Petrovsk south along the shores of the Caspian and the foot of the Caucasus range down to Baku; (2) by constructing a similar line from Novo Rossiisk along the shore of the Black Sea to Batoum, already in direct railway communication with Baku through Tiflis. Thus two railway systems skirting the Caucasus on the east and west extremities will unite in Baku. The strategic and economical advantages of this extension as regards the Asiatic provinces will be very considerable.

A word may be said about the petroleum industry at Baku. The engineer of Messrs. Rothschilds' works, who showed us round, informed us that the total yield last year was 300 millions of pûds, or about 5,000,000 tons. Petroleum consumed in Russia pays a duty of 40 copecks (10d.) per pûd of 36 lbs., while that exported to foreign countries is duty free, to enable it to compete with the Pennsylvanian oil. Practically all the machinery and plant except the roughest is imported from England, in spite of the enormous import duty, amounting to 1½ roubles (3s. 2d.) per pûd, or over 1d. per lb. The navvies employed on the works are mainly Tartars and Persians, who are paid 16 to 18 roubles per month, very high wages for unskilled labour in Russia.

THE TRANSCASPIAN RAILWAY.

Leaving Baku at 8 p.m., we crossed the Caspian to Uzun Ada, a distance of 210 miles, in 20 hours. The entrance to the harbour is a tedious and ticklish proceeding, through a labyrinth of narrow sandy islands and shallow channels carefully marked out with floating buoys and lightships. By midday we were opposite the bay of Krasnovodsk, hemmed in by the lofty Balkan range, rising in places to a height of 6,000 feet. The level of the Caspian, which loses more by evaporation than it gains from the rainfall and river discharge, is gradually sinking, and from this cause, as well as from the fact that when a strong east wind blows the channels of approach become so shallow from silting up, that steamers are unable to work their way into harbour, it has been decided to shift the port to its old position at Krasnovodsk, on the isthmus at the north entrance to the bay. The harbour of Krasnovodsk is deep and safe, and from a navigation point of view immensely superior to Uzun Ada, which was selected merely for its convenience as the starting point of the Transcaspian Railway. In other respects, however, Krasnovodsk labours under many disadvantages, (1) frequent earthquakes, (2) almost complete absence of fresh water, which must be obtained either from springs 14 miles off in the hills, where the supply is small and brackish, or by condensation of sea water, or conveyed by the railway. The change has, however, been finally decided on, and probably has by this time been carried out. One result of it is that the first 35 miles of the Transcaspian Railway must be abandoned, and from this point a new line constructed to Krasnovodsk, a distance of over 80 miles.

The construction and the strategical and commercial advantages of the Transcaspian Railway have been so fully and lucidly explained in Mr. Curzon's book, that no recapitulation is necessary. A few leading facts may be stated as to the circumstances of its origin and its actual working. The line was primarily undertaken to facilitate Skobeleff's expedition against Akhal Tekke in 1880. The preliminary surveys were carried out in the spring of that year, and the Imperial sanction to its construction was granted on 9th June. By 1st September, 1881, or within less than a year from turning the first sod, the line was completed to Kizil Arvat, a distance of 145 miles. The succeeding four years were spent in improving and consolidating this line. The next forward move was made in April, 1885, after the annexation of the Merv and Penjdeh oases, and the skirmish with the Afghans on the Kushk, on the 18th March, 1885, which made war between Russia and England imminent. It was determined to push on the railway from Kizil Arvat, through Askabad and Merv, to Amu Daria, on the left bank of the Oxus—a distance of 517 miles. Work was begun on 2nd July, 1885, and completed on 1st November, 1886, the rate of construction averaging 1⅙th miles per diem—a rapidity probably unsurpassed in the history of railway enterprise. The immediate necessity of the line for war purposes having been averted by the peaceful solution of the Afghan boundary question, it was decided, for commercial and administrative reasons, in June, 1887, to push on the line across the Oxus, through Bokhara, to Samarkand, so as to tap the Central Asian trade. This extension, which involved not only the construction of 230 additional miles of railway, but the spanning of the Oxus by a wooden bridge, was carried out by 15th May, 1888, when the line was opened to Samarkand. The total length from the latter city to Uzun Ada is 1,343 versts, or 895 miles, and with the changed alignment to Krasnovodsk, the new starting point, 1,405 versts, or 937 miles.

A further extension, which cannot fail to have most important commercial results, is now in progress. From Samarkand the railway is being continued across the Zerafshan river, which is already spanned by an excellent iron bridge, to Jizak and some distance beyond. At the latter point the line bifurcates. One branch crosses the Syr Daria, and runs to Tashkent, the capital of the Turkestan provinces; while the other runs south-east to Khokand, the commercial capital of Ferghana, and is eventually to be carried on through Marghilan, the official capital, to the Chinese frontier in the direction of Yarkand.

This latter branch will bring Samarkand and Tashkent into easy communication with the Pamir range, and facilitate the movements of troops in that direction. But its financial results in opening up the thriving province of Ferghana, with its rich, well-watered soil and growing cotton industry—the export of cotton is already estimated at over 30,000 tons annually—will be even more important.

The connection between Samarkand and Tashkent should soon be completed. Indeed, the slowness with which this part of the work proceeds is in marked contrast to the rapidity with which the masterly energy of General Annenkoff pushed through the main line.

In the spring in Moscow we heard that the line to Tashkent was already open; later on that trains were running half way; then, as we neared Samarkand, that it would not be open for traffic till July; while from what we saw with our own eyes and heard in Tashkent, it is very doubtful if it will be opened within a year. The engineering difficulties are considerable.

Besides the bridge over the Zerafshan near Samarkand, a bridge, which has not yet been taken in hand, has to be constructed over the Syr Daria (Jaxartes) and the Tashkent river, which we had to cross and recross in our *tarantass* no less than six times, will probably have to be bridged in more places than one. The fact is that the Tashkent people in general, and the Turkestan administration in particular, are by no means so keen on the connection with Europe through the Transcaspian Railway, which is under the control of the Transcaspian Governor-General. They are anxious to be connected with Russia by a line direct to Orenburg—now being surveyed—and connected with the Siberian Railway on the north.

The total cost of the open line to Samarkand is estimated at 51,000,000 roubles, or about £5,500,000, an average of about £4,000 per mile. The cost of construction seems very moderate compared with even the Indian standard, but it must be remembered (1) that the land cost practically nothing; (2) that the actual engineering difficulties were not serious, the line for most of its length passing through an absolutely flat and almost rainless country; (3) that no bridges of any size were necessary except that over the Kushk at Merv, and the Oxus at Amu Daria, and the latter is only a temporary wooden one, which it is now proposed to replace with an iron girder bridge, at an estimated cost of £1,000,000; (4) that the earth-work is of very slender proportions, rarely more than a foot or two above the level of the surrounding country; and (5) that cheap military labour was largely used.

The line is now in complete working order. A mixed goods and passenger train starts daily from each end, while the mail trains, which are speedier—covering the distance in sixty hours, or at the rate of fifteen miles an hour—and are fitted up with a dining-car and all other requisites for comfortable travelling, are despatched three times a week. Besides these there are occasional troop trains, and regular water-trains for the supply of the numerous waterless stations.

Great as is the importance of the Transcaspian Railway to the Central Asian provinces — from a commercial, strategical, and administrative standpoint—it suffers from many serious drawbacks, which have come more into prominence since Mr. Curzon's book was written. The chief of these are:—

(1) The defects of Uzun Ada as a harbour, and of the alternative port at Krasnovodsk as a site for one of the termini.

(2) The temporary wooden bridge over the Oxus at Amu Daria being always liable to be washed away by high floods. Little has yet been done to protect the bridge, or prevent the river from cutting for itself a new channel round it, by training works to direct the current into one stream, a method which has long been familiar to all railway engineers in India.

The bridge, as originally constructed over the main channel of the Oxus, had a length of 5,650 feet. But the Oxus flowing between low sandy banks has, like so many Indian rivers, a shifting channel and a licentious course, so that many supplementary smaller bridges and earthwork dams were necessary, making the total length from bank to bank 13,500 feet, or over 2½ miles. A high flood in July, 1889, washed away some of the smaller constructions, and the main channel shifted towards the east bank, rendering necessary a further widening of the main bridge, which has now an uninterrupted length of 8,700 feet, or nearly 1¾ miles. A wooden bridge of these dimensions can never be regarded as secure if subjected to serious and sudden floods. In June and July, after the melting of the snows in the mountains, the discharge per second rises as high as 190,000 cubic feet, and in July, 1890, exceeded 220,000 cubic feet, with a velocity of 8 feet per second, or 5½ miles an hour. Another high flood in the summer of 1894 almost carried away the bridge, which trembled, and was even slightly deflected by the current, and was probably saved from destruction by great masses of stone being thrown into the river to stem the force of the current.

Thus communications may any day be interrupted by the breakdown of the Oxus bridge, which, however, being of wood, is more easily repaired than an iron one; and a sufficient supply of ferry-boats is always kept in readiness for such an emergency.

Some steps are now being taken to straighten the channel and bring the river under control, but the only really satisfactory solution of the difficulty lies in the construction of a new iron bridge, and borings are now being made and levels taken with a view to this. The most convenient site, from an engineering point of view, is about fifteen miles further down stream. This would, however, involve a considerable change in the alignment of the railway, to which the Amir of Bokhara, whose dominions lie along both banks of the river, is said to have strong objections.

(3) The next serious drawback to the railway is the want of water at many places, which have, therefore, to be supplied by water-trains. Efforts are being made to supply this defect by the construction of *karezes*—the subterranean channels for the conveyance of subsoil water so familiar in Persia and in the submontane districts of the Punjab frontier. These *karezes*, which are generally constructed by Persian experts, can only be worked, however, close to hills containing an abundant store of subsoil water, and their application is, therefore, very limited. Attempts have also been made to supply the deficiency by artesian wells. The experiments made at the large cantonment of Askabad, where the borings have been carried to a depth of over 1,200 feet, have not been successful, but I believe that similar borings in the waterless tract between Merv and Amu Daria have been more successful.

4. The most formidable obstacle to communications has hitherto lain in the blocking up of the line by sand-drifts. I should estimate that for fully two-thirds of its length the line passes through deserts of sand. The sands are in places fixed, and these offer no difficulty. In places they are shifting, and a sand storm will often cover the line in a night to a height of 2 or 3 feet. The total length of these shifting sands traversed by the railway is put down at 170 miles, of which no less than 104 miles lie in an unbroken line between Kelcha and Amu Daria, in the Merv-Amu Daria Section. The evil has been intensified by the desert shrubs—*saxaoul*, &c.—which, striking their roots deep and broad into the sands, helped to consolidate and fix them, having been recklessly and shortsightedly cut down for firewood, &c., during the construction of the line. Of recent years steps have been taken to remedy this, and all such cutting has been prohibited within a distance of three miles on both sides of the embankment.

Among the other measures taken to prevent accumulation of sand may be mentioned (*a*), the widening of the cuttings, and the sloping away of the embankments where steep (*b*), the coating of cuttings and embankments with a layer of clay (*c*) the raising of the embankment above the level of the surrounding sand heaps, which are generally uniform in height and direction (*d*), the sowing of hardy desert plants and shrubs close to the embankment. These measures are gradually overcoming the incursions of the sand. Delays of trains from this cause are becoming less and less frequent, and are now extremely rare. The sum spent annually on clearing away sand-drifts does not exceed on the average £3,000.

The administration and *personnel* of the railway is purely Russian, and entirely military, indeed it is officially known as the Transcaspian Military Railway. The working staff consists exclusively of trained soldiers who have completed their period of compulsory service, and are now organised into two railway battalions. Except a few skilled labourers in the workshops, none but pure-born Russians are employed, and a Polish mechanic told us he would not have been employed had he not happened to be a Lutheran and not a Catholic. The natives are only employed, and even then most sparingly, for rough earth-work. They are no doubt beginning to use the railway more freely, especially the trading classes, for travelling; and though in theory there are no separate compartments for Russians and natives, in practice Russian travellers effectually exclude the natives from compartments which they occupy. There is no first class, but the second class *coupés*, especially in the mail trains, are extremely comfortable and well fitted up for summer and winter travelling. The fares are decidedly cheap, even by an Indian standard. A second-class ticket from Uzun Ada to Samarkand, about 900 miles, costs only 15 roubles, say 32s., or less than ½d. per mile. A third-class ticket costs 10 roubles, or about 21s. All the main stations—Kizil Arvat, Merv, Askabad, Amu Daria, Bokhara, Samarkand, are provided with good buffets; and the dining-car on the mail trains is little, if at all, inferior to that provided by the International Wagon Lits Company in Europe. I have said a great deal about the Transcaspian Railway because not only has it played a considerable part in the conquest of Transcaspia, but it is now one of the main agencies which enables Russia to maintain her hold over, and gradually civilise the stubborn Turkoman tribes, whose resistance was only broken at Geok Tepe, fourteen years ago, but who now acquiesce in the Russian dominion as calmly as if they had been subjected to it for centuries. As a Russian officer put it to me, the railway is worth a whole army of occupation. Certainly nothing more impresses a semi-barbarous race with the hopelessness of resistance than the spectacle of the forces of Nature being gradually overcome by the force of science. It is a remarkable fact that, during the whole period of the construction of the line, the Turkomans, though they frequently attacked the working parties, never once attempted to injure the line or derail trains. By bringing home to them the silent and potent force which could overcome the brute forces of Nature, the railway has been a more potent means of permanently pacifying the country than any army, while the material advantages of the line, as a means of transit for merchandise, have not failed to appeal to the shrewd commercial instincts of the native population.

There is another aspect of the Transcaspian Railway, directly interesting to us from a political point of view, viz., its use for a forward movement against Afghanistan or India, in case of a war with England. It was the probability of such a war, in 1885, that gave the impetus to the construction of the line beyond Kizil Arvat, and it is impossible to disguise the fact that the chief value of the line, from the ordinary Russian point of view, lies in its employment as a means of offence in the event of such a war. To complete its effectiveness for such a purpose the construction of two branch lines towards the Afghan frontier has recently been sanctioned. The first will run from Merv down the left bank of the Murghab to Ak Tepe in the Penjdeh oasis, near the junction of the Murghab and Kushk—a point only 120 miles north of Herat. The second will leave the main line at Amu Daria, and run along the valley of the Oxus through Bokharan territory, to Kerki ferry, near the boundary of Afghan Turkestan, and only 110 miles from the capital of that province, Mazar-i-Sherif.

The construction of this line was being talked of in the bazaars of Bokhara when we were in that city, the popular version being that the Amir of Bokhara was allowing the Russians to construct the railway through his territory in order to spite his good neighbour and much-hated rival, the Amir Abdur Rahman.

Returning to the Transcaspian Railway, it may be conveniently divided into three sections, according to the administrations it traverses. The first 638 miles, or over two-thirds of the entire length—from Uzun Ada to a point 28 miles west of the Oxus, where, and not (as often erroneously stated) on the east bank of the river, the Bokharan territory begins—lies in the province of Transcaspia. From the point above mentioned the line runs through Bokharan territory, including the Oxus, for a distance of 200 miles, while the last 60 miles lie in the Turkestan provinces. This division may conveniently be followed in the subsequent remarks which deal separately with Transcaspia, Bokhara, and Turkestan.

TRANSCASPIA.

Transcaspia has an area of about 220,000 square miles, and the population is estimated at 325,000. The soil is mainly useless wastes of sand. For the first 145 miles, along the railway from Uzun Ada to Kizil Arvat, hardly a tree or a vestige of cultivation is to be seen. At Kizil Arvat the railway approaches the range of mountains on the south forming the boundary between Russian and Persian territory. From this point on to the Tejend or Heri Rud river, a distance of about 300 miles, the railway runs close to and parallel with the range, whose snow-capped summits and bold outlines diversify the otherwise unbroken monotony of the scene. The wastes of sand and saltfields are in places dotted with small oases of cultivation, where the mountain torrents force their way through the lower hills, but they are soon absorbed in the thirsty soil; and it may be said that there is nothing north of this line but a wilderness of sand. The mountain streams are twenty-seven in number, and in places—as at Geok Tepe—the grave of Turkoman freedom—and Askabad, the official capital of the province, they water considerable areas, well wooded, and yielding plentiful crops of wheat, rice, maize, &c. Besides these streams there is some irrigation in the south-west of the province near the Persian frontier from the Atrek, the only river falling into the Caspian from the east, and its affluents, the Khandir and Sumbar. The sources of these rivers are, however, in Persian territory, and the supply of water is so variable and uncertain that they are of little use for cultivation. Here and there they spread out into marshes, and form rich pastures, but the plague of mosquitoes is so annoying as to be unbearable even to the thick-skinned Turkoman and his flocks and herds, which have to leave these happy hunting grounds in the early summer, for less nutritious, but less pestilential pastures.

A little west of the Tejend (Heri Rud) river, the mountain range on the south deflects to the south-east towards Sarakhs and Herat, while the railway strikes north-east through monotonous wastes of sand, which continue for about 250 miles to the Bokharan frontier, unbroken save by the Tejend and Merv oases, watered by the Tejend and Murghab. These two rivers, which, like all the rivers of Central Asia, except the Oxus and Syr Daria, with their affluents which flow into the Sea of Aral, eventually lose themselves in the sands north of the railway, are the main sources of irrigation in Transcaspia and, as irrigation is indispensable for cultivation here. it is from them alone that any material extension of irrigation and cultivation can be expected. Unfortunately, from a Russian point of view, the sources and main tributaries of both rivers lie outside Russian territory. The Tejend rises in the Siah Koh range north of Herat, flows first in a westerly direction to the Persian frontier, then due north, forming, first, the boundary between Persia and the Herat province, and further on from Zulfikar up to Sarakhs, between Persia and the Russian district of Merv. From this point it flows north-east through Russian territory, for a distance of about 190 miles, crosses the Transcaspian Railway at the station, named after it, Tejend, and splits up into a multitude of small channels, which disappear in the sands. In Russian territory, it forms only two oases around Sarakhs, and in the low swampy lands north of the railway, around Karibent. With these exceptions, its banks are uncultivated and uninhabited by any settled population. The Murghab rises on the northern slopes of the Sufaid Koh range, flows through Afghan Turkestan in a north-west direction, enters Russian territory a little south of Meruchak, where it is joined on the left bank by the Kashan, and a little further on it receives a more important tributary, the Kushk, the combined rivers forming the Penjdeh oasis. From this point it flows almost due north to Merv, where it intersects the railway, watering on its way the Yuletan and Merv oases. About 20 miles north of Merv, it is effectually dammed up by the famous Koushid-Khan Bund or embankment, constructed some 40 years ago by the joint efforts of the Turkoman tribesmen of the Merv oases. This embankment distributes the water into two great canals, the Otamish on the left, and the Toktamish on the right bank, so-called after the two chief tribes. From these main canals the water is distributed by a network of minor channels and irrigation works, under the supervision of *mirabs* selected by the tribesmen. The Otamish Canal is said to irrigate about 60,000 acres belonging to two tribes, while the Toktamish irrigates about 50,000 acres belonging to two other tribes. The dam, which is formed of reeds, brushwood and earth, has now become so consolidated as to be secure against any flood. It has a length of 840 feet, a height of 126 feet, and practically forms a reservoir 12 or 14 miles in length. For some miles below the dam the bed of the river is generally dry, but before it reaches Merv it is replenished by the springs in the bed, and the return of the waste water from the canals. At Merv it forms a considerable stream, which when we saw it in May appeared to be about 200 feet in width and of great depth. A few miles north of Merv the river is again tapped by a dam, which withdraws part of the supply. It then passes into low swampy lands, divides into several channels, which finally disappear in the sands about 100 miles north of Merv. The course of the river through Russian territory is about 270 miles. The average discharge is estimated at 3,500 cubic feet per second, of which probably about half is utilised for irrigation, and the rest runs waste.

As regards the irrigation system generally in Transcaspia, it cannot be said to be on a very sound footing. The Russian officials themselves are the first to admit this. Having had no previous experience of irrigation canals on any extensive scale when they conquered the country, they were chary of interfering with the existing system, and left the Turkomans to manage things in their own way. The Turkoman's conceptions as to utilising water are far inferior to the Persian's, and even to those of the Indian native. Everywhere one sees a network of channels, constructed with immense labour but with little knowledge of levels, badly aligned, often overlapping, and silting up with extraordinary rapidity. Apparently at the head-works there is no system of control by sluice gates, which would enable them to divert into the two main canals only the quantity of water required. All the supply in the river bed is turned into them, with the result that in high flood or after heavy rain the distributaries are unable to carry off the supply, which, therefore, breaches the banks, and floods the surrounding country, forming pestilential marshes and breeding malaria and fever. This occurred last year owing to the exceptional spring rains, and the heavy snowfall in the hills, and ever since the end of May the Merv oasis has been decimated by a most destructive epidemic of fever, which, according to the most recent intelligence in the Russian papers, has carried off over 4,300 people, out of a total population of 85,000, or rather more than 5 per cent.

Something may now be said of the native population. Of the total of 325,000 souls, the foreign element, excluding the Army—accurate figures for which, for obvious reasons, it was difficult to ascertain, but which I have reason to believe does not exceed 12,000 men—comes to 22,000, of which 9,000 are Russian; Persian, 5,000; Armenians and Tartars, 3,000 each, and miscellaneous, 2,000. The Russian element is concentrated in the towns of Uzun Ada, Askabad, Merv, and Kizil Arvat, and generally along the railway, and consists chiefly of officials, traders, and *employés* on the railway, as well as of the peasant colonists separately referred to further on. The Armenians are petty shopkeepers, traders, and contractors. The Persians and Tartars are traders and graziers, and to some extent agriculturists. The vast majority of the purely native population are Turkomans. The typical Turkoman is the free nomadic son of the desert, following a pastoral rather than an agricultural life, and moving about with his family, flocks and herds and household gods, according to the convenience of water or pasture. His black felt kibitka, which can be stowed away on a camel, is his nearest approach to a settled home, and even when he adopts a settled life, takes to agriculture, and builds himself a fixed habitation, he adheres tenaciously to the kibitka form, which may briefly be described as a cylinder with a hemisphere as a roof, the same aperture in the roof serving for a window and a chimney. For many generations, however, most of the Turkomans have adopted a settled life wherever conditions of water and soil enable them to support themselves by agriculture, as in the oases along the Tejend and Murghab, and this process has been considerably accelerated by the order and security which succeeded the Russian Conquest.

In physical bravery as well as in moral qualities the Turkoman is admittedly far superior to any other Central Asian tribe. Tall, handsome, with well-defined features and open honest countenances, they offer a striking contrast to the weak-eyed, effeminate Sarts and Tajiks of Bokhara and Samarkand, as well as to the snub-nosed, ungainly Mongolian Uzbegs with their broad cheek bones and heavy inexpressive faces. Their free, open air, desert life has not only given them an excellent physique, which is set off by their long *khalats*, an outer garment exactly like a dressing-gown, which is universally worn, and their high black sheepskin hats, which are worn equally as a protection against sun and cold all the year round; but also a certain rough and at the same time pleasing independence of manner rarely to be found among Eastern races. Truthfulness, honesty, and a thorough regard for the sanctity of a promise, for which the Turkomans are distinguished, are probably developments of the same free mode of life. By religion they are nominally Sunni Mohammedans, but are entirely free from fanaticism, and lean to indifferentism. The mullah is rare, and is hardly tolerated among them, and their *auls* or encampments are unadorned by mosques. Near some villages a square enclosure surrounded by a ditch is marked off as a place of prayer, and here now and then in the evening a certain number—generally the old men—assemble for their devotions, but the general attitude in religious matters appears to be one of good-natured indifference.

One evidence of their laxity is the fact that their women are rarely veiled, and freely take part in all out-door work. The same phenomenon may be observed among the nomad and pastoral tribes of the Punjab plains, and appears to be a natural consequence of the nomadic life. The general laxity in religious matters is no doubt accounted for by their roving desert life, remote from towns, such as Bokhara, Khiva, Samarkand, which are the centres of bigotry and of the Mussulman propaganda. Of late years efforts have been made to arouse their religious fervour, and inspire them with the proper spirit of Mohammedan intolerance, by sending among them mullahs from Bokhara and Samarkand. As far as can be ascertained, however, this propaganda has not been attended with much success.

Similar proselytizing efforts have been made by the Babist sect of rationalistic Mohammedans. On the execution of the founder of the sect by the Persian Government, many of its members fled from Persia and took refuge in the Khanates. Here they were subjected to fresh persecutions by the orthodox Mohammedans, but were well received by the easy-going, tolerant Turkomans, with whose accommodating views their broad rationalistic tenets found some favour. Thus in Askabad at the enumeration of 1892 over 100 persons returned themselves as Babists. Much interesting information about this curious sect, which has come again into prominence since the murder of the late Shah—generally supposed to be their work—was given me by Colonel Alikhanoff, but it would be going beyond our present subject to reproduce it here.

The social life of the Turkomans is nominally regulated by custom, but this custom does not extend beyond a few simple rules as to the distribution of land and water.

The family organisation is mildly patriarchal, but, at least, up to the Russian Conquest this was not allowed to interfere with the enjoyment of fullest individual liberty, which gave rise to their favourite boast "The true Turkoman needs neither the shade of a tree nor the shelter of authority." The Russian Administration has apparently grasped this fact, and leaves them to regulate their internal affairs as they please. The Turkomans on their part having been thoroughly crushed at Akhal Tekke and Geok Tepe, after a heroic and bloody resistance, appear, after the manner of Eastern tribes, to have passively acquiesced in the new order of things, and probably find that life goes on much as before, though the strong hand of the Central Government has done away with some of their pleasurable excitements, such as inter-tribal forays, and occasional raids on their hereditary enemies—the Kirghis of the steppes on the north-west, along the shores of the Caspian.

The gradual disarmament of the population which has recently been carried out here as in Turkestan, except along the Persian frontier, has, no doubt, contributed to the general pacification, which has made life and property in these wild tracts as safe as in the interior of Russia. Employment is found for the wilder spirits in the Frontier Mounted Militia, which mans the frontier posts jointly with Cossack Irregulars—eight Turkomans and four Cossacks per post—and is employed in watching the frontier, preventing smuggling, conveying the post and urgent messages, and in escorting the executive officials in their tours. This militia is, however, only a very small body. Colonel Alikhanoff, who, after the affair of Penjdeh—known among Russians as the "affair of the Kushk"—was for many years in charge of the Merv district, which his influence with the tribesmen enabled him to acquire for Russia without the firing of a shot, informed me that in peace time it consists of only 300 men; but the number can be raised to 2,000 in time of war. This insignificant force represents the only thing in the shape of a native army, a fact that is worth remembering in view of the general impression that Russia freely admits the recently-conquered tribes into her armies, appoints their chiefs colonels and generals, and has at her disposal thousands of irregular Turkoman cavalry, who only await the signal to pour into Afghanistan and India, carrying fire and sword before them. The Turkomans, though they possess brave and warlike qualities, appear to be at heart a peace-loving people. In this respect, they cannot, perhaps, be better described than by the epigram which the Russians are, with some justice, fond of applying to themselves—"The Russians are a nation of warriors, but not a warlike nation." The favourite amusement of the Turkomans appears to be to assemble in the nearest bazaar on market days, and sit in groups, calmly discussing local events, or the latest political developments. They may be seen riding in from all quarters. Your genuine Turkoman never walks as long as he can find a horse, camel, donkey, or even an ox to bestride. They are strictly temperate as regards wine, though opium smoking, which is sternly prohibited by the Administration, is said to be creeping in among them from Persia, the home of every Eastern depravity. The Turkoman is rarely a trader. He makes his living by cattle-breeding, agriculture or gardening; but even those who are engaged in agriculture still to some extent retain their flocks and herds and pastoral life, and after sowing the spring crop, in October and November, they pack up their kibitka, and migrate with their cattle to their favourite pastures, returning in March or April, when the crop is ripening. After the harvest, the cattle are again sent off to the mountain pastures till the autumn crop is ready, and are then brought back to graze on the stubble, or be fed on the maize and jawar stalks till the winter migration begins.

Private property in land, in the full sense of the term, can hardly be said to exist among the Turkomans. The usufruct of the land depends on the ownership of the means of irrigation, without which the land is valueless. A man's property is reckoned by the number of shares of water he is entitled to. Rights in water may be either common, as in the case of running streams, canals, or open springs, or private, when the water is obtained from the earth by irrigation works constructed by private enterprise. Usually it is a share of water which is transferred by inheritance, gift, sale or mortgage. By Turkoman custom every adult male has a right to a single share of water, with the usufruct of a corresponding area of land, and is bound to assist in the maintenance of the irrigation channels. Those who do not care to work their own shares may transfer them to relations, or lease them out for a share of the crop. Similarly land may be held in joint or individual usufruct. The latter is alienable, but only to members of the same tribal subdivision. The former is inalienable, but may be rented out, generally for a year, the income being divided among the community. The area held in individual usufruct is said to be small as compared with that held in common usufruct, and the latter is subject to frequent redistribution. The cultivation is shifting, owing to the great abundance of land as compared with the means of irrigation. Most Turkomans cultivate their own land, and their democratic organisation, combined with periodical redistribution, prevents the accumulation of large areas in the hands of individuals. Hired labour is rare. At harvest time a man calls in his neighbours to help him in getting in the crop, entertaining them royally, the familiar *wangar* of the West Punjab. The methods of cultivation and the instruments used are rude and primitive. For ploughing they use horses, camels, buffaloes and oxen, all four varieties being sometimes combined in a single team. The soil is rich and not exhausted by long centuries of cropping, and from a sufficiency of water the yield is excellent. Around Merv the crops of wheat and barley were in May last as good as any I have seen in the north of India. The harvests are much the same as in the Punjab. The spring crops, wheat, barley, turnips and carrots, are sown from September to November, and ripen in April and May; the autumn crops, maize, rice, cotton, jawar and melons are sown in March and April, and come to maturity from July to September. The crops are cut with a sickle, and the grain is trampled out on the threshing-floor by horses or donkeys, in place of the oxen of India, the chopped straw being stored for winter fodder as in India.

In saying that the Russian element in the population was confined to the towns and the railway, I overlooked the Russian Peasant Colonies which the Administration is endeavouring to plant along the Persian and Afghan frontiers. These have long been another bogey to certain Russophobists and alarmists in India, who look on the rooting of a permanent Russian element in the soil as an immense gain of strength to Russia for purposes of aggression. As a matter of fact, extremely little has yet been done in this direction, and the results of that little have not been very encouraging. The first settlement was made in 1887-88, when some fifty Russian families were located in territory ceded by Persia in 1881, Persia withdrawing her own subjects on condition that Turkomans should not be allowed to settle in their place. There are now in all a dozen of such colonies scattered along the Persian and Afghan frontiers. The most southern of these latter is the Settlement of Alexeeffsky, on the Kushk river, about 200 miles south of Merv, and only 70 miles north of Herat. This was started in 1892, when sixty-one families from the Kharkoff Government, numbering 415 souls, were transplanted thither, and assigned land close up to the Afghan frontier, after the fashion of the old Roman settlements against the Barbarians on the lower Danube. I was unable to obtain any information about this colony at first hand, but a Russian acquaintance, who had recently visited the settlement on the Persian frontier, about twenty miles west of Askabad, where some fifteen Russian peasant families were located some years ago, and allotted a large area of fertile irrigated land, informed me that the colonists were dissatisfied with their position, and had no intention of permanently settling there. The cause of their dissatisfaction did not appear to be any want of land, cattle, or other resources—they were fairly thriving materially—but the fact that they were looked upon, presumably by their fellow-countrymen, as if they were Persians or Turkomans like their neighbours; and their national pride rebelled against any such comparison with conquered or inferior races. The feeling will be readily intelligible to those who have any experience of India. On the whole, the colonisation experiment, though conducted on a very modest scale, and though the settlers have received considerable aid from the State, including money-grants in some cases, does not seem so far to have been a success.

Some say that the fault lies in the selection of the colonists, and then attribute it to the incapacity of the moujik to shake off his home prejudices, and adapt himself to a new environment and new conditions of agriculture. The same remarks apply to Russian colonisation in the Turkestan provinces. The conditions there are much more favourable, owing to the greater abundance of suitable land and the less rigorous climate. The results have not been satisfactory. A certain number of Cossacks and moujiks have been settled around Tashkent and in the hill district of Ferghana, but in no case have they taken firm root. The reasons alleged are that many of them were broken-down men, who had already failed elsewhere; that they had no capital; and that the areas allotted, 14 to 35 acres per head, were too small to attract solvent men. Several of these colonists, we were told, had already thrown up their grants. In any case, the experiment can never be carried very far in the Transcaspian province owing to the insufficient supply of water for irrigation, and the fact that all land irrigable from existing channels is already occupied. An extension of cultivation can, therefore, only be obtained by an extension or improvement of the irrigation system, and several schemes have been projected by the local administration with this object.

The most ambitious of these is the project of damming the Atrek in the south-west of the province, and utilising its waters, all of which now run waste, for irrigation purposes. The scheme was worked out in 1890, but disputes arose between the Russian and Persian subjects as to the rights of enjoyment in the water—the sources of the river are in Persian territory—and the execution of the work has had to be deferred to "a more favourable opportunity," *i.e.*, till the Persian authorities are in a more yielding frame of mind.

A more practicable scheme is that for the irrigation of the eastern part of the Merv oasis, around Bairam Ali, the site of the ruins of the ancient "Queen of the World." This tract, now almost waterless and uninhabited, was up to the close of the last century rich and thickly populated, being irrigated by a canal, known as the Sultan Ab, fed from the Murghab by means of an immense dam known as the Sultan Bund. This dam was destroyed towards the close of the last century by the invading army of the Bokharan Amir, Shah Murad, who laid waste the country, and transplanted the conquered Turkomans into Bokharan territory. Since then the eastern half of the oasis has remained a waste, and after the Russian conquest it was formed into the "Imperial Estate of Merv," the private property of the Emperor. At present only an insignificant area is cultivated, with the aid of an irrigation cut leased from the neighbouring Turkomans. But soon after annexation, an attempt was made to restore the ancient prosperity of the tract by renewing the former dam. The work was entrusted to an engineer named Pakeffski, and was carried on for years at an enormous cost, some millions of roubles, but no attempt seems to have been made to train the river, and no sooner was the dam completed than the Murghab cut its way round it, forming a new channel, and leaving the dam high and dry, and useless. Further attempts to dam up the stream at this point were abandoned, and on the advice, I believe, of Sir Colin Scott-Moncrieff, whose services were lent to the Russian Government for the purpose, a new project was formed, the object of which was to head up the water further down stream by a weir, and, by means of sluices, divert it into irrigation channels commanding the area included in the "Imperial Estate." After many unsuccessful attempts the weir was finally completed in July, 1894, and though this by no means disposes of the difficulties, it is an important step gained. I believe the engineers in charge of the works hope to be able to utilise by its means most of the surplus water of the Murghab—after the Otamish and Toktamish canals have been supplied. I was unable to obtain any figures as to the area or breadth irrigated by the new project, but understand it is very limited.

The necessity of bringing new lands under cultivation by means of irrigation is all the greater, not only to provide for further settlements of the Russian element, but also in view of the increasing population, which is being swelled, since the Russian occupation, by immigration from Bokhara, Persia, and, on the north-east near the Caspian, by nomad Kirghiz tribes from the Ural Government, from which they have been forced out by the pressure of the increasing Russian element. The most daring scheme of all—which if realised would, it is hoped, restore the ancient prosperity of the Turkoman wastes, and have far-reaching political consequences—is one for the diversion of the Oxus from its present course into the Sea of Aral, to its supposed ancient bed, running from some point in the vicinity of Khiva, due west, into the Caspian. This is one of those vague but magnificent projects which appeal so strongly to the Russian nature, and has been one of their day-dreams since the days of Peter the Great and of Bekovitch's ill-fated expedition against Khiva in 1715. Certainly the vision of through water communication from St. Petersburg and Moscow to Khiva, Transcaspia, Bokhara, Afghanistan, and the Pamirs, by means of the Volga and its tributaries in European Russia, the Caspian and the Oxus in Asia, is one that dazzles the imagination. An exploring party under General Glokoffski were at work on the scheme for some years in the last decade, and another expedition under the same officer has recently been despatched to explore the ground and report on the feasibility of the project, which some Russians already talk and write about as if easily realisable, and as destined to solve the Central Asia question, and bring the markets of India within easy reach. Even if the scheme is feasible and unobjectionable—and it could not be carried out without the Khivan settlements between the point of diversion and the present mouth of the river on the Sea of Aral being ruined by the loss of the irrigation—it is very doubtful whether it would be of much benefit from the point of view of navigation or of irrigation. The Oxus, even in its present channel, is an almost impossible river to navigate for any but vessels of the smallest draught. Curiously enough at no point, from its source to its mouth, does the Oxus lie exclusively within Russian territory. From its source in the Pamirs it forms, first, the boundary between Russia and Afghanistan; then for a long distance the boundary between Bokhara and Afghanistan, after which it flows exclusively through Bokharan territory and thus through Khiva to the Sea of Aral. It may, however, be regarded for political purposes as a Russian river. Accordingly at Amu Daria an Oxus flotilla of river steamers is maintained by the Russian Government, which plies between Kerki ferry, about 130 miles up stream, and Petro Alexandrovsk, 200 miles down stream, and only some thirty miles from Khiva. The steamers are small, but, owing to the frequent shifting of the channel, and the rapid formation of sandbanks and shallows, navigation is carried on, especially against the current, with the greatest difficulty, and the pilots have often simply to feel their way along. A Russian traveller describing his experiences states that starting up stream from Amu Daria in seven hours they covered only fifteen miles, and the steamer being unable to proceed further through the shallow channels, they were transshipped into a boat. Even this in places had to be punted along. With a treacherous and ever-shifting channel, an exceedingly swift current, which rapidly erodes the low sandy banks and throws up numerous obstructions in the shape of sandbanks and islands, it is no wonder that the Oxus has not come up to the great expectations formed of it as a means of communication. The steamers of the flotilla are never able to accomplish their passage with any approach to punctuality, and this is perhaps the reason that according to official statistics in the year 1892 the number of passengers carried by them only amounted to 1,658, and the weight of goods barely exceeded 2,000 tons. Under these circumstances, it seems futile to expect that the Oxus can ever become an effective means of communication, unless enormous sums are spent in opening up and keeping clear its channels.

Nor are the prospects of increased irrigation from the Oxus much brighter, though the possibilities are undoubtedly great. It is calculated that the Oxus discharges into the

Sea of Aral a volume of water averaging 50,000 cubic feet per second, and most of this might, with a proper canal system, be utilised for irrigation. The delta of the river, from Amu Daria Station to the sea, has an area of about 4,000 square miles, most of which is excellent cultivable land, but only about one-tenth of this is at present under cultivation. Great part of the remainder is covered with reeds and jungle growth, where the banks are low and the surrounding land readily inundated, or with unwholesome swamps and marshes, hotbeds of malaria. New canals would, therefore, have a double advantage. They would enable waste land to be brought under cultivation, and by reducing the inundation would gradually drain the marshes, and render them fit for cultivation. As already explained, however, the river on leaving the Afghan frontier for the rest of its course, runs solely through Bokharan and Khivan territory; and it is doubtful whether these states can command either the means or the skill that would enable them to carry out any such extensive projects.

It is a fact, however, that up to 1852 there existed west of Amu Daria an extensive canal, which irrigated an enormous area on the left bank of the river. In that year, Said Mahomad, the Khan of Khiva, being at war with the Turkoman tribes who owned these lands, caused the dam to be cut away and the canal to be filled up in order to hasten their submission. The renewal of this canal on a larger scale has for some time been talked of, but it is easier to pull down than to reconstruct; and, shorn as it is since 1873 of its sovereign rights, and much of its territory, Khiva is hardly in a position to undertake the work. The complete annexation of Khiva and Bokhara is, however, openly admitted by the Russians, and apparently believed by the native population of the Khanates, to be only a question of time. This feeling paralyses all measures of improvement on the part of the State, and till these tracts come into Russian hands no decided action can be anticipated. Meantime, the Russians might with advantage study the principles of canal construction, in which they seem to be lamentably weak. What seems to be wanted is fewer visionary schemes, and more active work.

BOKHARA.

In the foregoing remarks about the Oxus, I have rather travelled beyond Transcaspia, and may now say something of the Bokharan State, which is like a wedge driven in between the Russian dominions in Transcaspia and Turkestan, a connection, however, being maintained by the railway, which, for the 200 miles of its course through Bokhara, is practically a continuation of Russian territory. Bokhara has an area of 92,000 square miles, and a population of about 2,250,000. The population of the capital—still the most important commercial centre in Central Asia—is about 70,000. The Amir and the ruling caste are Uzbegs, a conquering tribe of Mongol origin. The nobles, officials, and military classes belong almost exclusively to this caste, but the vast majority of the settled population, agricultural and trading, are Tajiks and Sarts—aborigines of Aryan origin. There is also a considerable nomad population, composed of Uzbegs and Turkomans, the latter more especially west of the Oxus, which is the natural boundary between the Turkomans and Uzbegs, and over these the Amir's authority is said to be only nominal. In the principal towns, Charjui, Karshi, and, above all, in Bokhara itself, there is a considerable sprinkling of Jew and Armenian merchants, as well as a colony of Hindus from the Punjab and Sind. The Amir's dominions have been much contracted since the conquest of Samarkand by the Russians in 1868, when Bokhara became a vassal state of Russia, with, however, as complete internal independence as the dominion of the Nizam of Haidarabad. The new Russian town of Bokhara has grown up round the railway station, eight miles from Bokhara city, with which it is connected by an excellent metalled road. The Russians, not fully realising perhaps the unchanging conservatism of the East, are in hopes that it will speedily attract the trade from the old city, and two hotels, three banks, and several private business firms have already begun operations. After the Russian fashion, the town is laid out rather with a view to the expected future than to the actual and present needs. Too much cannot be expected from a place of almost mushroom growth, but when we passed through on our way to Samarkand, it was a sea of mud, and on our return, a fortnight later, a desert of dust. The development is entirely Russian in character. Native capitalists and native capital have not yet been attracted hither. One great drawback at present is the want of water, which has to be drawn long distances from the canals; but this is in a fair way to be overcome by the construction of a system of waterworks.

The Russian diplomatic agent for the Bokhara State has his headquarters here, and a company of Cossacks, for guard and escort duty, is the only visible embodiment of Russian military force. The present agent is Major Ignatieff, who succeeded M. Lessar, the famous Asiatic explorer, in 1895. Besides his diplomatic functions, the political agent, assisted by a consul, also exercises judicial powers in all cases between Russians. Cases between Russians and natives are inquired into by him in the first instance, and, if my information is correct, he, if satisfied that there is a *primâ facie* case, sends it on to the native judge, specially appointed by the Amir for New Bokhara, and this official also takes cognisance of all cases between natives.

The present Amir, Syed Abdul Ahad, succeeded to the throne in 1885, and is understood to be decidedly Russian in his sympathies, and has made several journeys to Russia, where he has always been received with much pomp and state. He owes his throne to the Russians, who supported him against the rival claimant, his half-brother, who, as the son of a free wife, is thought by many to have a superior claim. The latter took refuge in India, and now resides at Abbotabad. This year Syed Abdul and his retinue, along with the Khan of Khiva, were among the most picturesque personages in the brilliant coronation spectacle at Moscow. His younger brother is a lieutenant in a regiment of the Russian Imperial Guard. He himself holds the honorary rank of a General of Cossacks, and when he left Bokhara, during our stay there, by special train on his way to Moscow, he was attended by a Cossack guard of honour. The Amir's Russian leanings have by no means found favour with the mullahs and fanatical part of his subjects. It is said that he does not consider his life safe in the city. He rarely lives there, and is now building for himself a new palace near the railway, and close to the Russian town, where he would be able to rely on Russian aid in case of an *émeute*.

Certainly he is wise not to depend on his own ragged and ragamuffin army. In Bokhara, we were told that this army numbered 10,000 men, but this force, of course, would include police and tax-collectors. The latest Russian writers put the numbers at only 3,200. In Bokhara itself, the military element is very little in evidence. A handful of soldiers in the jail, anxious for backshesh, and a squad on duty at the Palace, arrayed in something resembling the Russian uniform, lolling half asleep on the ground, while their arms, old-fashioned muzzle-loaders, were piled some way off, were the only samples of the "army" that we met with. The rumours one hears of in India, where the tendency is to magnify everything connected with the progress of Russia in Central Asia, as to the Bokharan troops being reorganised on modern lines by capable Russian officers, are entirely imaginary. The only thing Russian about the army, excepting the uniform, is the Amir's military band, which, I believe, has a Cossack bandmaster. The Bokharan private receives the equivalent of about 7s. per month, and has to "feed" himself.

To see Bokhara one should make one's headquarters in the native city. An excellent two-horsed phaeton, with a Russian driver, covers the eight miles from the railway station in an hour. The road runs thorough a rich, densely-populated tract, irrigated by wells and canals. As you approach the city, crowds of Bokhariots are met with, generally riding on donkeys, and the road now runs between well-wooded gardens, enclosed by lofty mud walls. Of these, the most remarkable for its size, and the magnificent trees, is the Amir's pleasance, including his summer palace. The city itself, nestling in an ocean of green foliage, has rather an imposing appearance from a distance, with the lofty Minar Kalan, a splendid tower 220 feet in height, lifting its head proudly in the centre; but a nearer view produces a disillusion. Instead of the royal palatial city of the Arabian Nights, to which you have been looking forward, you come upon a city built of mud, with narrow, tortuous, unpaved streets in which you can hardly breathe for want of air. The only buildings of stone or brick are the Minar, the two great mosques, the Liabehaus or bathing place, and the madrassa or religious university, all of which have, I think, been described in Mr. Curzon's book. Even the Amir's palace or fort is of mud, though the main gateway is of brick, and is crowned by an immense clock, the hands of which, however, have stood still since the unfortunate Italian architect who erected it was put to death 50 years ago for refusing to embrace Islam. When one reflects on the fate of the many victims of Mohammedan intolerance, and in particular on the cruel lot of our own adventurous countrymen—Stoddart and Conolly—who, within living memory, were slowly done to death here in a hideous underground dungeon, one cannot repress a certain feeling of exultation that the strong hand of Russia has now rendered such atrocities, at least in the case of Europeans, impossible. As regards the native subjects of the Amir, the fury of fanaticism appears to be as violent as ever. The Sunday before our arrival a Sart, who had insulted a mullah, was accused by the latter of insulting the true faith, condemned to death by the Kazi, dragged through the streets tied to the tail of a camel, pelted with clods and stones, and spat upon by the fanatical populace, then slowly hanged, drawn and quartered, and thrown to the dogs outside the city wall. Capital punishment, unknown in Russia except for the most heinous political offences, is frightfully common here. Hanging, decapitation, and shooting are the usual methods of execution, and we were told at the jail that four prisoners were to be put to death on the following Sunday. A visit to the jail, zinda, which can be arranged by a little backshesh to the guards, presents a spectacle which cannot easily be forgotten. Huddled together in two small rooms not more than 15 feet by 12 feet, partly underground, dimly lit from the roof, and in an atmosphere of almost intolerably fetid heat, were about 50 prisoners of all ranks and ages. Most of them were in rags, and emaciated, for the State provides neither food nor clothing, and we had to "pay our footing" by distributing loaves of bread, which were eagerly snatched at by the half-famished inmates. By day they are as a rule left unfettered, but are chained up at night.

The one thing in Bokhara which does not disappoint our expectations are the bazaars. For order, neatness, and variety, though not in the richness of their contents, they far surpass not only the bazaars of India, but those of Cairo and Constantinople. The bazaars of Broussa in Asia Minor are the only ones I have seen which run them close. The best way to see them is to put up in the inn—very clean and comfortable for an out-of-the-way place like Bokhara—kept by Shillinski, a German Russian. The host is courteous and well-informed in local politics, provides a guide and supplies photographs of the chief sights of the city. The bazaars are a series of cool arcades covered in at the top, and connected together by means of a picturesque crypt from which they radiate as from a centre. Each bazaar usually represents a separate industry, such as copper and silver work, silk, carpets, brocade, and embroidery, cloth and cotton piece-goods, food-stuffs, sweetmeats, &c. All are kept scrupulously clean and pure, are regularly watered, and the wares are displayed with considerable taste and skill. Even the butchers' quarter is a model of cleanliness. All this is a refreshing novelty to any one accustomed to the slipshod bazaars of India, with their foul smells and myriads of flies. The contents of the shops, too, show a very high standard of comfort, even of luxury, for the East. The sweetmeats would tempt even a European taste. Tasteful packets of soap and little phials of scent show that the native population pay more attention to cleanliness and personal adornment than is usual in the East. Some of the bazaars seem to contain only cheap and showy Moscow goods, stamped cloth, muslin, teapots, leather-work, cutlery, &c., and here, as in India, the cheap manufactured article of Europe appears to be rapidly driving out the product of local native labour. The embroidery and work in copper and silver seemed to be much inferior to what we get in India, and relatively much dearer.

The native-made carpets—nearly always the work of women, who are rarely to be seen in the street, and are much more closely veiled and strictly kept than their sisters in India—and shot silks, and many coloured silk embroideries, for which Bokhara is famous, are reasonably cheap. As a rule, they can be obtained if the purchaser has time and patience for two-thirds or three-quarters of the price first asked, but the Bokhariot has little of the keenness of the Indian trader, with whom you can always do a deal, and, wrapped up in lofty seclusion, with a cup of green tea beside him, he seems to be quite indifferent whether you make a bargain with him or not. This, of course, does not apply to the Jews, who are now among the richest merchants of Bokhara, though subject to several humiliating disabilities, *e.g.*, they are not allowed to ride in the city, they must wear dark clothes, and must wear a girdle round their outer garment in contradistinction to the flowing robes and many-coloured garments which give the Sart the appearance of a walking flower garden. English goods, which twenty years ago and even later were in great demand here, being introduced direct through Persia or through India and Afghanistan, are now rarely seen, and those which are still imported are kept carefully in the background, so as not to give offence to the Russians, who are striving, and with complete success, to monopolise the Central Asian markets for their own manufactures. The one article of English make in universal demand is the fine white muslin, used for the pugris o the well-to-do Mussulmans, the like of which cannot be produced outside England.

The great measure by which Russia is excluding foreign goods from Central Asia was the inclusion, in 1884, of Bokhara and Khiva within the Russian Customs line. This measure, however necessary from the point of view of Russian fiscal administration — which was seriously hampered by the existence within its borders of two separate and independent system of customs and transit duties, much less oppressive, too, than those prevailing in the adjoining Russian territories—in all probability marks the downfall of the commercial pre-eminence of Bokhara. That pre-eminence rested on the fact that the Bokharan market was open to the goods of all the world, subject only to a trifling import duty of $2\frac{1}{2}$ per cent. This liberal and far-seeing policy established in Bokhara a large direct commerce, not only with Khiva and the Russian territories, but with Persia, Afghanistan, India and China. Bokhara thus became the great centre for the exchange of the products of those countries, somewhat after the fashion that London serves as the exchange mart between Europe and the New World, and her very sound gold and silver currency enabled her to play the part of the clearing-house for Central Asia, and to set the exchange for all the countries with which she had dealings. The construction of the Transcaspian Railway, which encourages through trade at the expense of local, the inclusion of Bokhara in the Russian Customs system, involving an enormous increase in the import duties, and the fixing of a compulsory fixed rate of exchange between the rouble and the Bokharan coinage, are all fatal blows to the commercial independence and pre-eminence of Bokhara, which, in course of time, will probably sink to the position of a market for the exchange of Russian with Central Asian goods. Naturally, such a sweeping change cannot fail to arouse dissatisfaction, not the less deep because it cannot be freely expressed. The introduction of the Russian tariff, the proceeds of which are shared equally by the Amir and the Russian Custom-house, has enormously increased the price of imported articles, especially of the green tea from India, which had come to be regarded as a necessity of life by even the poorest classes, and is now, with the heavy duty, almost beyond their means.

I must not omit to mention that there is a considerable Indian colony in Bokhara, said to number 200. Their headquarters is the Phul Serai, where we interviewed some of them and were hospitably received, our hosts offering us the contents of their cigarette cases, and, mindful of our Indian tastes, endeavouring to supply us with the national whiskey and soda. These Hindus are nearly all Banyas from Shikarpur in Sind, but there are also Pathan traders from Peshawar, Mussulman Khojas from Bhera, &c. The Hindus are subject to the same social restrictions as the Jews, and are said to be even more unpopular than the latter, as they live almost by usury. They are not allowed here no more than in Russian territory to acquire land by sale or mortgage, and complained of the difficulty of getting their claims decreed and enforced by the Kazi, whose orthodoxy, however, is not quite proof against infidel gold.

They never bring their families here, and all look forward to returning to India. Many of them frequently return to their native land, and bring back Indian goods, either direct through Cabul, or by way of Persia and the Gulf, and sometimes by the Caspian and Constantinople. Living among a hostile and fanatical people, they have to be very careful in carrying out their religious ceremonies, and their chief grievance seems to be that they were not allowed to celebrate the Ram Sala with becoming pomp.

Cultivation in Bokharan territory is dependent entirely on well and canal irrigation. Something has already been said of canal irrigation along the Oxus. Wells are numerous in the valley of the Oxus and around Bokhara itself, and can be worked with advantage, as the water level in those tracts is reached at from 10 to 30 feet.

The Persian wheel is in general use, as in North-West India, and the wells are worked by oxen, buffaloes, and occasionally horses. The eastern portion of Bokhara is fairly well watered by the Oxus and its numerous tributaries on the right bank. The central portion around Bokhara city and north-east towards Samarkand, *i.e.*, the Bokhara and Kara-kul oases, is irrigated mainly by canals from the Zerafshan (gold-scattering) river. Since the annexation of Samarkand, however, the upper waters of the Zerafshan have passed into Russian hands, and the increasing demands for water in the Samarkand district, owing to the settling down of the population, and the steady extension of cultivation under a settled government, have considerably diminished the supply available for Bokhara. In consequence nearly all of the Kara-kul oasis in the vicinity of Khoja Daulat has been thrown out of cultivation, abandoned by its inhabitants, and is rapidly relapsing into wastes of sand. Even Bokhara itself sometimes suffers severely from the necessary demand for water in Russian territory, which naturally has first to be satisfied. In 1895, according to the Governor of Samarkand, who controls the supply, and who has a very delicate task to hold the scales evenly between the claimants, half of the cotton crop in Bokhara perished for want of irrigation at the critical time.

To cope with this great and growing difficulty, it has been proposed to utilise the surplus waters of the Oxus, but the engineering difficulties of bringing a large volume of water a distance of 80 or 90 miles through shifting sandhills, where the loss by evaporation and absorption would be enormous, are very great, and are hardly likely to be overcome by a native administration. True, a similar project, but of even larger dimensions and greater engineering difficulties, has been worked out for the irrigation of a very similar tract in the Sind Sagar Doab in the Punjab, between the Indus and Jhelum, by a canal taking out of the Indus at Kalabagh, but then the Indian Government has at its command almost unlimited funds, and the most capable body of canal engineers in the world. For the present, therefore, further agricultural development in Bokhara, as in Transcaspia, is arrested by the want of irrigation. In fact, existing cultivation has a difficulty in holding its own. Bokharan agriculture is, however, far superior to anything in Transcaspia. The cultivators, generally Sarts of Aryan origin, have been long settled on the soil, and have acquired that hereditary aptitude for making the most out of the land, with primitive instruments, which characterises the Indian peasant. Holdings are small. Around Bokhara, they average less than 3 acres, and the cultivation has, therefore, to be very careful and intensive to enable the cultivator to make a living. The State takes nominally four-tenths of the crop, instead of the one-tenth prescribed by Mohammedan tradition, but this represents payment for the water as well as the land. The land revenue collections are usually farmed out by the year to contractors, who pay a fixed sum to the State Treasury, and either realise in kind from the cultivator, or compound with them for cash payments.

The crops grown are roughly the same as in Transcaspia; but the agriculture is superior, and the proportion of valuable crops, cotton, rice, &c., higher. In places the soil shows traces of exhaustion from over-cropping, and the inevitable *reh* — the curse of canal-irrigated tracts—is very common, and in places has thrown large areas out of cultivation. Large agricultural villages, which are common in India, are hardly seen here. The peasants live separately on their holdings, or a few houses are grouped together round a well. Where land is at all valuable, the fields in Bokhara and Turkestan are enclosed by mud walls, which must cost enormous labour to construct and maintain. The houses are built as if for defence —a survival no doubt, of the old days of lawlessness, being enclosed by a lofty courtyard supported by little mud bastions, and often with little turrets at each corner. Here, too, in Transcaspia, little earthen towers are to be seen in the fields, where the cultivator took refuge in case of sudden attack. Similar circumstances have, I believe, given rise to similar means of protection along the Peshawar border.

The Aryan origin of the Sarts, whether employed in trade or agriculture, is easily traceable in their clean-cut oval faces and regular intelligent features, which form an agreeable contrast to the high-cheek bones and heavy stupid faces of the Uzbegs and other Mongolian tribes to be found here and in Turkestan. The Sart or Tajik—both names appear to be used almost indiscriminately—in mental qualities takes first rank among the Central Asian races, is the most industrious cultivator, and the shrewdest trader, but in physical and moral qualities he is inferior, not only to the Turkoman, but to the Uzbeg. Living at his ease in a softly-watered land, he has—as so often happens with Mohammedans in similar circumstances—*e.g.*, in Eastern Bengal, become effeminate and depraved, losing the hardy virtues which mark the semi-nomadic Mohammedan tribes, and acquiring in their stead a rancorous bigotry.

Probably in no other part of the Mohammedan world is the influence of the fanatical and pestilential mullah so strong as in Bokhara. It is still the chief seat of Mohammedan learning in Central Asia, and, as has been already remarked, missionaries from its madrassas and mosques are endeavouring to extend their influence among the Turkoman tribes, and imbue them with their own spirit of fanaticism.

RUSSIAN TURKESTAN.

Leaving Bokharan territory at mile No. 836 from Azun Ada, the railway enters the

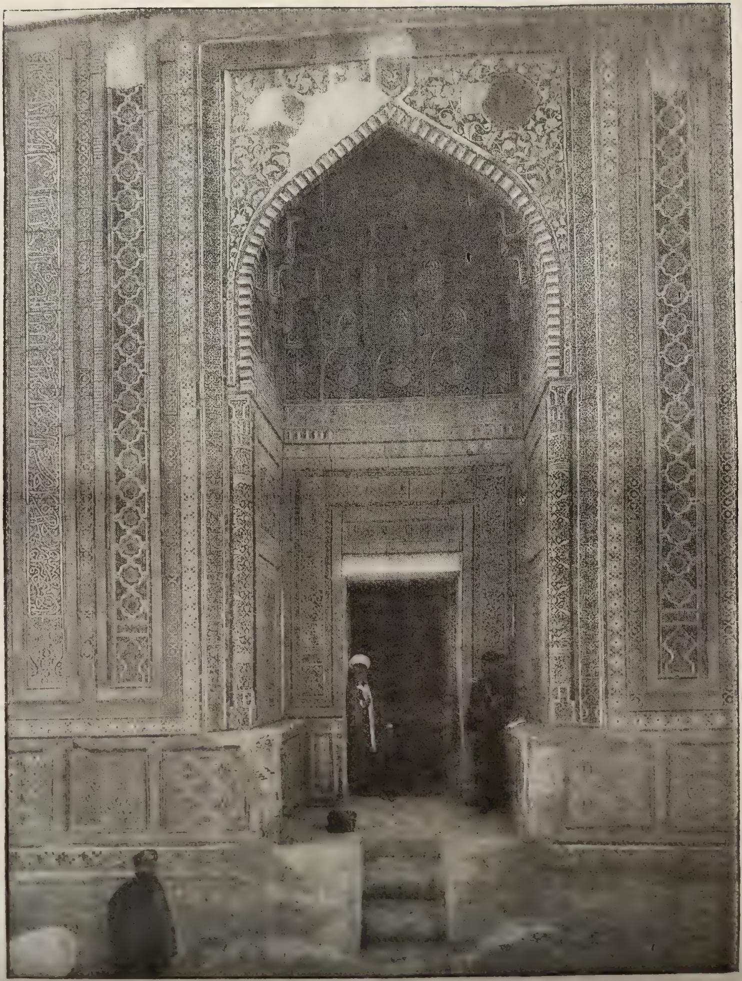
Samarkand province of Turkestan, and a further run of 60 miles brings the traveller to Samarkand. I shall never forget the impression made on me as we approached that city on a beautiful April morning. We had gone to sleep on the previous evening surrounded by the sad-looking, monotonous deserts of sand, and woke up at five next morning to find ourselves transported, as if by magic, into one of the most beautiful scenes in the world. We were running through the valley of the Zerafshan, now clothed with all the verdure and freshness of spring, and covered with waving crops, bright streams of running water, noble poplars and acacias. To the right and left rose two lofty purple mountain ranges, their peaks all covered with freshly-fallen snow sparkling with a rosy hue in the early sunlight. Even in Kashmir one rarely meets a scene so beautiful, and one ceased to wonder that the early Moghuls in India, Baber and Humayoon, looked back with longing to the fresh beauty of their native land. At 7 a.m. we reached Samarkand, the new Russian town, which is quite separate from Tamerlane's ancient capital, now a second-rate city, with a population of only 30,000, and is almost lost in a sea of foliage—flourishing gardens, noble avenues of poplars, willows, and acacias. It is carefully laid out on a regular plan, with broad streets, along the sides of which flow streams of running water fed from the Zerafshan, along which, and sometimes in the centre of the road too, are planted magnificent avenues, so thickly that they almost shut out the sky. The extraordinary height and size which these avenues have reached—all have been planted by the Russians since the conquest of Samarkand in 1868—bear witness to the marvellous fertility of the soil with sufficient irrigation. Indeed the profusion of trees and water in and around Samarkand, and the want of proper sanitary arrangements so characteristic of Russian towns, have seriously affected the healthiness of the place. Malarial fever is very prevalent, few — whether Russians or natives—escape it. The new town too is built on the site of ancient graveyards, which adds to the general unhealthiness. We were told that in 1892 the Governor ordered great numbers of trees to be cut down with the view of improving the climate, but the town and vicinity are still far too thickly wooded to be healthy.

There is little of interest in the native city, a huddled collection of one-storied mud houses, with narrow confined streets, which at the time of our visit were almost impossible rivers of fetid filth. Owing to the strict seclusion of the women, here, as in Bokhara and Tashkent, there are no windows looking on to the street, and this gives the houses a mournful and prisonlike appearance. Surrounding the city stand the magnificent remains of the palmy days of the Moghul dynasty. The tomb of Tamerlane, the Bibi Khanum or mausoleum, raised in honour of his Chinese wife, the Shah Zindeh or mausoleum of the soldier saint of that name—supposed to be a cousin of the Prophet—who was the first to conquer and introduce Islam into Samarkand, have been so fully and eloquently described by Mr. Curzon that it is unnecessary to add anything here. The photographs will give some idea of their present condition, which is one of rapid decay, to arrest which little has yet been done by the Administration. The vandal natives have not scrupled to remove bricks and tear away the exquisite mouldings in variegated tiles from the noble edifices for the adornment of their own houses. Under this ruthless process of plundering the Bibi Khanum— the most stupendous monument of Moghul times—is rapidly disappearing. The interior of the building is sometimes used as a cattle pen, which reminds one of Goldsmith's lines :—

> " As in those domes, where Cæsars once bore sway
> Defaced by time, and tottering in decay,
> There in the ruin, heedless of the dead,
> The shelter-seeking peasant builds his shed,
> And, wondering man could want the larger pile,
> Exults, and owns his cottage with a smile."

The tomb of Tamerlane is now protected from such indignity by the custodian priests, and a family of Saiyeds looks after the mausoleum of Shah Zindeh. The latter, though not very imposing from the outside, contains some of the best specimens of Mohammedan art that I have seen anywhere in the world. A succession of magnificent gateways present the most wonderful effects in blue, green, and yellow tiles, exquisitely moulded to represent fretted panels. The work appeared to me finer than the famous green enamel of the Broussa mosques. Not less impressive are the cool, arcade-like cloisters, connected by arches of perfect proportions, and the separate mausoleums of the relations of the Shah—each a cathedral in miniature, perfect in shape and proportions.

The social life of the native city centres in the Righistan, a large and magnificent square, bounded on one side by the main road leading through the principal bazaar to Tashkent, and



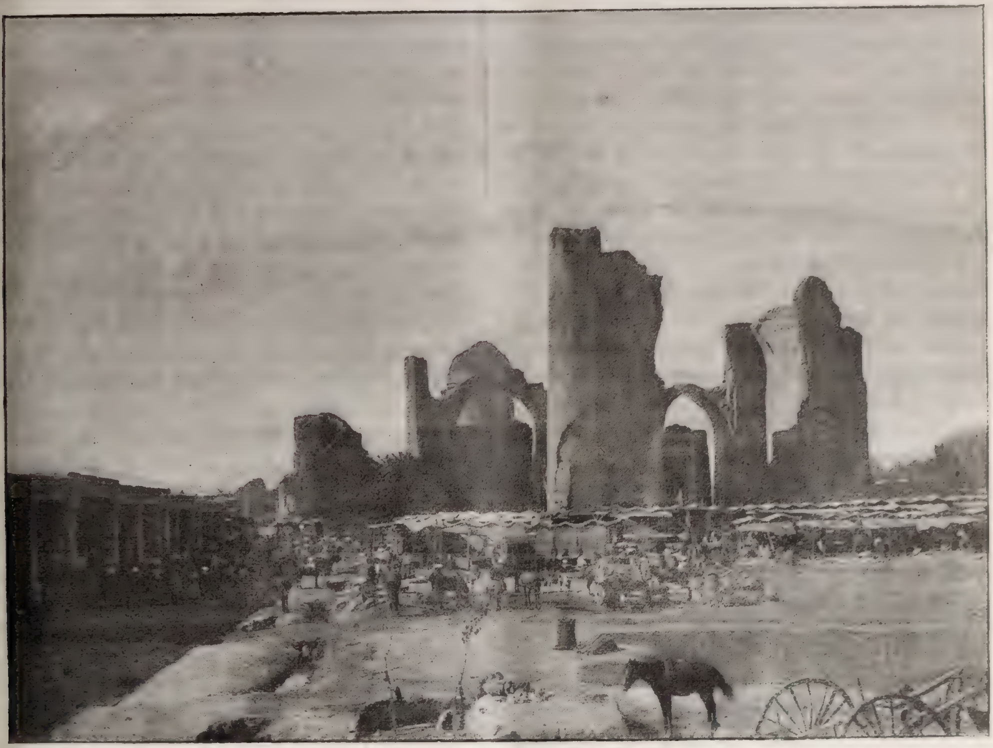


FIG. 3.—MOSQUE AND MADRASSA OF KHANUM BIBI, SAMARKAND.

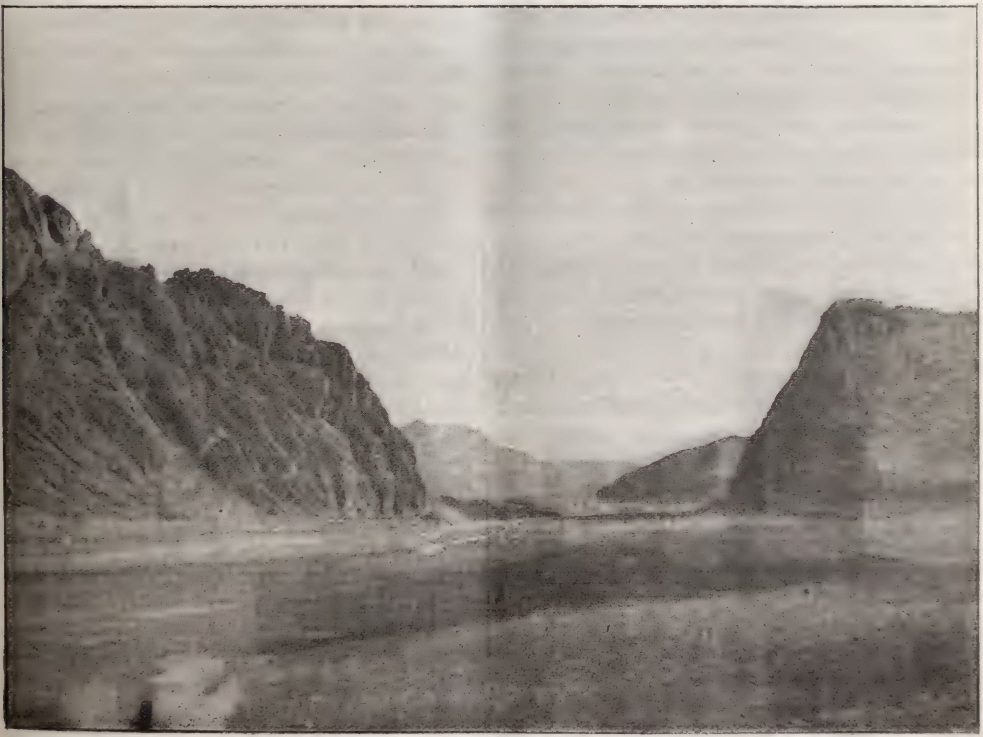


FIG. 4.—GATES OF TAMERLANE.

on the other three by the three famous madrassas or Mussulman colleges, known as the Tili-Kàri, the Shahr-Dár, and the Ulug Beg. The scene here on market days, when the merchants and tribesmen collect for business or gossip, is one of the most striking and characteristically Oriental that can be seen in the East. Here are to be seen Uzbegs, Tajiks, Turkomans, Afghan, and Persian horsedealers, Kirghis traders in solemn groups calmly discussing the events of the day. Here a native bard holds a large audience spellbound with the recital of the deeds of the ancient kings, emphasising his remarks by striking his wand on the ground, and worked up to the proper pitch of fervour by a colleague or disciple who sits opposite to him, and gives him a lead by plying him with appropriate questions. There a group of mild-looking Dervishes with conical yellow hats trimmed with fur and loose many-coloured kaftans, singing a weird dismal chant, beg for alms. Close by a spirited auction of old carpets and the familiar Eastern juggler divide the attention of the public. Pale watery-eyed and vicious-looking mullahs and religious students from the adjoining madrassas move noiselessly in and out among the squatting crowd; vendors of water melons, cooked food, and sweetmeats loudly advertise their goods; while the Russian element is represented by a travelling cutler, and a few groups of hardy-looking Cossacks, who, with an air of good-humoured condescension, rub shoulders with the native crowd. Above the bright blue cloudless sky of the East, and around the noble monuments of Moghul sway, which have witnessed many a grisly sacrifice of human heads on this historic spot. Only the brush of Vereschagin could reproduce such a scene, and any one who has gazed on his pictures of Samarkand past and present will realise the scene more clearly than my words could convey.

There is a wonderful fascination about Samarkand, even now in the days of its decay, that induces the traveller to linger there. Its glorious situation, its historic past, and its magnificent remains of departed greatness all combine to impress the mind. I well remember how all these rose up in the mind as we entered the city on a brilliant evening towards the end of April, on our way back from Tashkent. Below us the beautiful valley of the Zerafshan lay bathed in the warm mellow glow of the evening sunshine; far away to the north and south the white snows glistened brightly, gradually changing to a rosy red. Close by the city lay nestling in a mass of thick dense green foliage, the grand old Moghul monuments rising prominently round it like giant sentinels, while the bright blue cupolas of Shah Zindeh and Tamerlane's tomb flashed back the rays of the setting sun. As the last glow of evening lit up the city with a warm rosy light, it recalled to one's mind Tennyson's beautiful phrase, "A rose-red city half as old as time." Central Asia is worth a visit if only to see Samarkand.

There is also much of living interest in Samarkand as the headquarters of one of the best administered and most progressive provinces in Turkestan. Turkestan is perhaps less important politically than Transcaspia, which is in contact with Persia and Afghanistan, while Turkestan stretches down to the Pamirs, and on the east is bounded by the Chinese provinces of Kashgar or Yarkand.

In all other respects, however, Turkestan is more important, and financially it is growing more and more so every year. The area is in round numbers 410,000 square miles, with a population of 3,350,000 souls. It is administered by a Governor-General (the present incumbent, Baron Vrevski, has held the office for the last seven years), whose headquarters are at Tashkend. It is divided into three provinces or governments, Samarkand, Syr Daria (the capital of which is Tashkent) and Ferghana, with the capital at Marghilan. Tashkent is the administrative civil and military headquarters, and has a population (120,000) greater than that of any Russian town in Asia. In commercial importance it is, however, being outstripped by Khokand, in the Ferghana province, which has a rapidly developing trade in cotton and Chinese goods.

This is a convenient place to say something of the Russian system of administration in Turkestan and Transcaspia. It is essentially military in character, the Governor-General, governors of provinces and districts, sub-divisional officers, being all Russian military officers. The Governor-General of Turkestan and Transcaspia are *ex-officio* in command of the local forces, said to be 12,000 in Transcaspia and 30,000 in Turkestan. The Transcaspian province, or *oblast*, is sub-divided into three districts, *okrugs*—Merv, Krasnovodsk, and Askabad—each under the control of a district officer, *okrujnoy nachalnik*, generally with the rank of colonel or lieutenant-colonel, and corresponding to the magistrate and collector of India. These districts are again subdivided into two or more subdivisions (*uezds*), corresponding to the tahsils of an Indian district. The officers in charge of these *uezds* are also invariably Russians, generally of the rank of captain. These subdivisions are further sub-divided, for police purposes, corresponding to the thanas in India, and the police officer is also a Russian; while, for revenue purposes, they are divided into *volosts*, parallel to the zails of the Punjab, village communities, and groups of fifty houses. The *volostnoy* or official responsible for revenue collections, and assisting generally in the administration throughout the *volost*, is generally a native magnate of some influence, elected by the people every three years, and is remunerated by a cess levied on the native population, which, in Turkestan, averages annually 800 roubles, and about £100 per *volost*. Similarly the *starshinis* or village elders, and the representatives of the groups of fifty houses, are chosen by election every three years. The system of local administration by triennial election is borrowed from Russia, where all the peasant representatives are selected by election every three years, the time-expired men being liable for re-election. In the Asiatic provinces, it is, however, applied also to the election of all the native, judges and kazis, as well as to the municipal representatives in the towns of Samarkand and Tashkent, which enjoy a form of municipal self-government, the Russian members outnumbering the natives in the proportion of two to one. Turkestan being much larger and ten times more populous than Transcaspia, is divided, as already stated, into the three *oblasts* or provinces of Samarkand, Syr Daria, and Ferghana, each under a governor, generally of the rank of general. This, in its turn, is sub-divided as in Transcaspia into *okrugs* or districts. There are, I think, five in all—*uezds* or tahsils, and police jurisdictions, *volosts* or revenue sub-divisions, village communities, and groups of 50 houses.

The civil organisation based on that in vogue in European Russia is, therefore, very similar to that obtaining in India with this difference, that in India we receive less high-sounding titles, but more solid remuneration. Thus the governors-general in Asia receive £2,000 to £3,000 per annum. The governors of provinces, corresponding to the Indian districts, as in European Russia, receive 7,000 to 9,000 roubles per annum, or an average of about £800, but I was informed by an official who is in a position to know that in time of war they can double this by grants from the Secret Service Fund.

The officials in charge of *okrugs* or districts, and *uezds* or subdivisions are paid respectively about half and one-third the above sum, that is about £400 and £250 per annum.

The position of the *pristav* or police officer is analogous to that of an inspector in India. He is generally of the rank of lieutenant. What is important to note in view of the general belief in England and India, that the Russians are much more liberal than we in India in admitting natives to high office in the civil and military administration, is that every one of these posts in Transcaspia and Turkestan, with the exception, I believe, of one inspectorship of police is held by a Russian; nay more, not only are the natives excluded from the post of subdivisional officer corresponding to tahsildar or mamlatdar, which in India is invariably held by a native, but the subdivisional officer's staff, with assistant secretary and two clerks, are all Russians. The only posts which natives up to this hold in the civil administration are those of interpreter to the governors, and in the various offices one or two have, I believe, been appointed *pristavs*. They are absolutely excluded from all share, however humble, in the Executive Government. It may be said that this is inevitable in Transcaspia, most of which has been annexed only within the last fifteen years, and where there are few natives with the necessary educational qualifications, but in Turkestan, which has been in Russian hands for now close on thirty years, and where numbers of Sarts and Kirghiz are now to be met with who have acquired a good Russian education, this argument does not hold good, indeed, it could only be advanced by admitting that thirty years of Russian civilisation had failed to produce a single native worthy of office.

The state of things in the Army is the same. In Turkestan as in Transcaspia there is no native army, and there is not a single native in the Russian army of occupation. The impression, not uncommon in England and carefully fostered by a certain section of the native press in India, that Russia admits the Central Asian natives to high posts in the army appears to be based on the single instance of Colonel Alikhanoff, who came into such prominence in connection with the Penjdeh incident in 1885. Even that single instance does not support the case for Alikhanoff is not an Asiatic at all, but a

Caucasian Mohammedan of the Avar section of the Lesghian tribe, which has been subject to Russia for 100 years. There is, we were told, a small militia, from which men are selected for the native police force. There are few, if any, of the brave Turkoman tribes in Turkestan, indeed, they are rarely found east of the Oxus. The inhabitants—Tajiks, Sarts, Uzbegs, Kirghiz, are much inferior as fighting material to the Turkomans—the ease with which the Russians took Tashkent and Samarkand is a proof of this—and in course of time will gradually lose what fighting qualities they once possessed, as they have now been disarmed.

This disarmament of the native population is another fact not generally known in England or India; but while we were in Transcaspia and Turkestan, I never saw a native carrying arms. It may, therefore, be safely asserted that the Russians keep the civil and military administration of the Central Asian provinces in their own hands. The reason for this is partly no doubt political, but it is also partly due to the fact that the Russian will work almost as cheaply as the native. There is very little difference in the standard of comfort. Living is a little dearer in Asia, and this is recognised in so far that the pay of the officers is 50 per cent. higher than in Europe, but the pay of the rank and file is the same. In fact the Russian finds himself more or less at home in Central Asia. The climate is not very different from European Russia, extreme heat alternating with extreme cold, though, of course, the winter is shorter and the summer longer. At Merv, Askabad and Samarkand, snow lies on the ground for a couple of months, and 40 degrees of frost in the winter is not uncommon at Merv.

Hence we find Russians competing with natives in every branch of labour, skilled and unskilled, and both working side by side in perfect amity, and receiving the same wages. The *isvoschiks*, or cabdrivers, are generally Russian—often soldiers who have completed their service and have preferred staying on in the east to returning to Russia; the *tarantass* drivers on the postal routes from Samarkand to Tashkent and Marghilan are indiscriminately Russians, Tartars, or Uzbegs, paid usually 12 to 15 roubles a month. The postmasters at the changing stations are invariably Russians of the moujik class, so are the servants in the inns and restaurants. I am told that after the Russian conquest there was a general influx of artisans, carpenters, blacksmiths, masons, &c., from Russia, but the native Sarts, who are quick to learn, rapidly picked up these trades, and are gradually ousting the Russians, owing to their superior steadiness and sobriety. Great numbers of the navvies on the new railway are also Russians.

The shops, large and small, in the Sadr bazaars of Merv, Tashkent, and Samarkand, are generally in Russian hands, though there is a sprinkling of Armenian, Persians and Jews. In fact, the Russians are not merely a small ruling caste, as we are in India, but also constitute an integral and considerable portion of the non-official population, and this, of course, enormously strengthens their hold on the country, which has become thoroughly Russified, not merely by the administration being Russian, but by the prevalence of Russian settlers. This is much more marked in Turkestan than in Transcaspia. The Russian settler in Central Asia does not find himself, as the Britisher does in India, face to face with an entirely novel and alien civilisation, but with an earlier stage of his own civilisation.

The courtesy of the Governor of Samarkand enabled us to visit the jail, the schools, and the native tribunals, and a few words may be said about these as illustrating the practical working of Russian administration. The jail at Samarkand is a pleasant-looking building with some architectural pretensions, standing in a fine garden. The head jailor, a retired Russian officer who has spent 20 years in Turkestan, and in whose face kindness and humanity were clearly written, seemed to stand to the prisoners—some 200 in number—more in the relation of a kindly host than of a stern janitor; indeed, from what we saw—and I am sure it was genuine and not put on for the occasion—the prisoners ran some risk of being killed with kindness. Russian prison discipline, except for political offenders, is extremely lenient as compared with our English system, and approximates rather to the Indian standard. Capital punishment is never inflicted except for political offences or by sentence of court-martial. Among the prisoners in Samarkand jail were several who had committed heinous murders, but the severest sentence was three years' imprisonment. This, too, was of the mildest kind. Solitary confinement is almost unknown; fetters do not appear to be used at all. The prisoners if they choose may wear their own clothes, and may purchase their own food, being denied only wine, opium, and tobacco. The food supplied by the State seemed to be excellent in quality and ample in quantity. A rich meat and vegetable soup plays a large part in it, and meat is given three times a week. Among the prisoners were several Russians, but no distinctions were drawn between them and the natives; they are housed in the same barracks and share the same food. There is a jail library for the benefit of literate prisoners, a church for those professing the orthodox faith, where the jail chaplain holds service every Sunday, and an open-air mosque for the Mohammedans. Among the Russian prisoners some were wanderers of the vagabond class, who, being without passports, had been arrested to be sent back to their birthplaces. One was a Moujik from Central Russia, who had wandered hither in search of a faithless Helen, said to have eloped with a Cossack. Others were refugees who had tried to escape from Siberia. All the prisoners, native and Russian, had a sleek and well-fed appearance. They are certainly not overburdened with work; there seemed to be no allotted tasks. Those who chose might spend the day in their cells or barracks; others amused themselves with light work in the jail garden and in the work-rooms. Three Uzbeg murderers, unchained and unfettered, were engaged in a little mild yarn spinning or light carpentering, and others were engaged in blacksmiths' work. The Russians look on our jail labour, especially on the treadmill and oakum-picking, as barbarously cruel, while to our ideas their system errs on the side of excessive leniency. As in India, each prisoner has a little book indicating his name and the offence for which imprisoned, term of imprisonment, date of release, &c. The head jailor was quite shocked when we began to inquire from some of the prisoners the offences of which they had been convicted, and evidently thought it cruel to recall this to their minds.

The jail is visited three times a week by the medical officer. In cleanliness, neatness, and the excellence of the sanitary arrangements, it contrasts most favourably with the state of things in Russian private houses even of the better class. The jail guard, including warders and extra-mural guard, consists of twenty-eight men — time-expired soldiers—a small force considering the number of prisoners and the large area covered by the jail buildings. Altogether this glance at the jail was an agreeable surprise, though to our minds it speaks more for the humanity than for the punitive or deterrent effects of the system. Indeed, in Russia one hears general complaints that since the pampering of criminals came into vogue, crime has been steadily on the increase.

From the jail we went on to the Kazi's Court. There are Russian tribunals for Russians, and native judges for the natives. Like the *mirovoy sudi* or stipendiary magistrates in the towns of European Russia, the native kazis and judges are elected every three years—one for each group of 2,000 houses by the representatives of the groups of 50 houses. The triennial elections were impending while we were at Samarkand, and the Governor informed us that they give rise to much excitement and wire-pulling among the native population, who resort to all the machinery of the caucus as in America, supplemented by Oriental intrigue. The system is fairly popular with the natives and seems to work fairly well, but is decried by the older class of Russian officials for the same reasons that the introduction of local self-government was opposed by many officials in India—as premature, and leading to party spirit and intrigue. There is some weight in these objections, but the Russian Government, in its love for logic and uniformity, has determined to mould the administration of its new conquests as far as possible on the model of European Russia. There is, however a safeguard against the selection of unfit persons, as the Governor has a right of veto and may select a candidate with fewer votes to his credit. The Governor informed us that he had done this recently when the police reported unfavourably on the character of the candidate with most votes. The main advantage claimed by the Russians for the elective system is that it pleases the people and relieves the administration of the responsibility attending the administration of justice, as the people have only themselves to blame if they select a corrupt or unjust judge. The argument has much in its favour, but would hardly find favour with British administrators. The judges so selected are remunerated by a percentage—I think 10 per cent.—on the valuation of the suit paid by the parties, have jurisdiction without limit in civil cases, and in criminal have power of imprisonment up to 18 months. An appeal lies to the bench of native judges sitting jointly, and the Russian court has a power of revision, but only in case of a mistake of law or procedure. It cannot alter the finding or sentence, but may send the case back for retrial.

A short drive through the native city, through streets knee deep in liquid mud, brought us to the place where the chief kazi was dispensing justice in patriarchal fashion, in a verandah looking out on an open courtyard, with a tank and shady trees. The kazi was an amiable, intelligent-looking old gentleman, who knew only a few words of Russian, but spoke Persian fluently. The parties presented their plaints, written in the local Turki dialect, and without court fee stamps. The suitors knelt with folded hands during the progress of the case, their friends and witnesses standing in the background. The kazi, after reading the plaint and defence, put some pertinent questions—no form of oath being used—to the parties or witnesses. The cases were all of a civil nature, decided according to the Koran, and where any point of law arose, he referred it orally or in writing to a mufti, or person learned in the law, who was not present in court, but appeared to be somewhere round the corner. The latter sent back his opinion almost at once, referring to the verse of the Koran on which it was based. When a difficulty arose as to the facts, it was referred to two arbitrators appointed by the parties. The proceedings, notwithstanding frequent interruptions for the inevitable tea, sweetmeats, cigarettes, and other hospitalities, moved smoothly and speedily. In the course of an hour, or an hour and a half, the kazi disposed of two cases of disputed mortgage, in one of which the interest, 30 per cent. per annum, was allowed to stand; one of guardianship, in which a youth, who claimed to have come of age, wished to set aside a dishonest guardian; and one of divorce, in which a young husband gave the first formal divorce—three are necessary to make the divorce final and operative—to an elderly wife. The second mortgage case is worthy of special mention as throwing some light on the habits of the people. Five co-sharers had mortgaged a house in the native town, with all legal formalities, and put the mortgagee in possession. A third party came forward, claimed to be a sixth co-sharer, and sued to have the mortgage declared invalid, as made without his knowledge and consent. The case was referred to arbitration to clear up the facts, and after the parties had left the court to select arbitrators, a person who seemed to have no direct interest in the case volunteered the information that the claimant was a man of straw, that the mortgagee was using the place as a house of ill-fame, and that the neighbours, wishing to put a stop to this scandal, had put forward a fictitious *soi-disant* co-sharer to sue to have the mortgage set aside as illegal. The case is typical of the tortuous ways which Orientals choose to arrive even at a laudable result.

Before describing the schools we visited, a few statistics as to education may be quoted. In the year 1893 there were in Turkestan 90 Russian middle and primary schools, with 258 teachers and 4,124 pupils. Mixed schools for Russians and natives numbered only 23, with 533 pupils. There were also 15 night schools for adult natives, attended by 400 pupils. The mixed schools, in which Russians and natives learn side by side, look very well on paper, but in practice they are boycotted by the Russians; so, assuming that as many as 500 out of the 533 pupils in such schools are natives, we have out of a population of 3,350,000, of which at least 3,250,000 are natives, only 500 native boys and 400 native adults receiving instruction on the Russian system in Russian schools. There are, however, besides the above schools a certain number of purely native primary schools supported by the State, in which instruction is given in Russian by Russian teachers, and in the Persian and Sart languages by native teachers. From whatever point of view the figures are looked at they cannot be regarded as satisfactory. There is only one gymnasium or upper school for boys—from which they can proceed to the university or professional institutions—in the whole of Turkestan. This is at Tashkent, and is said to be attended almost exclusively by Russians, so that there are either no facilities for the higher education of natives, or they do not care to make use of them. In fact, the Russian officials and settlers complain bitterly of the want of educational facilities, and are driven to sending their children to European Russia for higher education.

The native population appear still to look with suspicion on the State schools, and many of the Sarts prefer to start schools at their own expense for instruction in Russian. The Kirghiz, who are as free as the Turkomans of Transcaspia from religious prejudices, are the only race that make free use of the State schools, but they are comparatively few, and the majority of them are still in a nomad or semi-nomad state. The Sarts composing the vast majority of the town and settled agricultural population are rather bigoted, and the influence of the mullahs makes them send their sons to the purely Mohammedan mosque schools. Of these there are great numbers in all the towns, but the instruction given in them is chiefly religious, one-sided, and unpractical. In Samarkand alone, which is second only to Bokhara as a centre of Mohammedan learning in Central Asia, there are no less than 23 madrassas or schools for higher Mussulman education, attended by 800 scholars, and 83 primary schools, with over 1,200 pupils. These figures for a total native population of 23,000 show how ardently Mohammedan learning is still cultivated. One reason no doubt of the indifference to the State schools is that the study of Russian, though it has its uses for commercial purposes, does not open the door to State employment. The experience of India shows us that the desire for place is the most powerful stimulus to education among a semi-civilised population.

And yet nine Russians out of ten are convinced that we, for our own wicked and selfish ends, are keeping the peoples of India in Cimmerian darkness; and when told of the thousands of English middle-and upper schools, and of the five universities, all established, and managed by the State, they murmur a polite assent, but remain sceptical in their inmost hearts.

The first school we visited was the mixed Russian and native, in which instruction is given solely through the Russian tongue. There were only two or three Russian boys—and I doubt if even these were true Russians—to about 30 natives. The school building was an excellent one, and was very well equipped with books, maps, desks, &c. The masters were all Russians, or at least Russian-speaking. The instruction was similar to that given in primary schools in India. We went on to one of the Government primary schools for natives. We found about 30 boys in attendance, nearly all Sarts or Kirghiz, perhaps one or two Uzbegs. Instruction is given in Russian by Russians, and in the Sart or Turki language by natives. The boys seem to have a difficulty, with which we could fully sympathise, in getting round the subtle Russian vowel sounds, and in fighting their way through the many-syllabled Russian words. It was pitiable to see that nearly all of them suffered from weak or bad eyes. All over Central Asia ophthalmia and cataract seem to be very common. We should have liked to see the measures taken to afford medical aid to the natives, but were not shown the hospital or dispensary, though we expressed a wish to see it.

We next visited one of the mosque schools, which offered nothing remarkable. The boys learn the Koran by rote, in a parrot-like fashion, shouting out the verses in a shrill chorus, and keeping time by swaying their bodies to and fro. Altogether, what we saw and heard of the schools gave us the impression that education is still in a very backward state, and that the natives have not yet to any considerable extent abandoned their own primitive religious system in favour of the more practical Russian course.

Lack of funds is, no doubt, the main obstacle to progress in this direction. Neither Transcaspia nor Turkestan has ever yet succeeded in paying its own way, and the supplementary grants from the Central Finance Department are a continual and increasing drain on the Imperial Exchequer.

The revenue system in Turkestan—of which I can give only a very brief and rough description, based partly on the results of inquiries from officials, but mainly on the imformation imparted by Jew and Kirghiz merchants—appears to be something on the following lines:—Excluding excise duties on the wine and beer, which is manufactured locally and is very cheap, and custom on imported goods, the revenue raised from the native population, includes (1) land tax, (2) house tax, (3) kibitka tax—all these three are levied on the rural population—and (4) town tax, on the urban residents.

1. The house tax is a uniform assesment of $1\frac{3}{4}$ roubles—about 4s. —levied uniformly on all houses, except those in towns, as well as on the kibitkas of the nomads, without distinction.

2. A kibitka tax of 4 roubles—about 9s.—is levied on every nomad kibitka, which pays house tax as well, and probably represents a state charge for the free and unrestricted pasturage which the nomads enjoy. It acts, therefore, as an incentive to the nomads to form permanent settlements, as by so doing they escape this tax.

3. The town tax, corresponding to the *kvarterny nalog* of European Russia, is fixed in lump by the Administration—of course with reference to previous collection, the state of trade, &c.—and is distributed over the different quarters or sections, and within them among the groups of 50 houses, and then over separate houses by the representatives of these groups. The Administration interfere very litttle in the distribution, leaving the natives to manage this in their own way.

4. The land tax is, of course, far the most important. There is nothing in the nature of the fixed assesments for a number of years,

with which we are familiar in India. Every year the Governor-General, after consulting the local officials, and taking account of the harvests and general condition of the country, fixes, in consultation with the Finance Minister at St. Petersburg, the total demand. Having obtained sanction to this, he apportions it over the different provinces. The provincial authorities similarly distribute their quota over the districts and subdivisions, all this, of course, being done in consultation with the local officials, and with reference to past collection, nature of the rents, &c. Having then worked out the demand for each subdivision or *uezd* the further distribution over the *volosts* or zails is carried out by the *volostnoy* or zaildan, in consultation with the sub-division officer. In practice, from this stage downwards, matters are left, as far as possible, in the hands of the natives themselves. Within the zails the demand is spread over the village communities by the *volostnoys* and *starshinis*, or village representatives, and worked out for the groups of 50 houses and individual householders by the latter in consultation with the people. This part of the system would hardly work in India, where the people are so litigious and mistrustful of one another that they are wont to look to the officials rather than to their own representatives to settle every trumpery dispute arising out of their relations to one another. In Turkestan, however, where the traditions of patriarchal rule are still fresh, and material confidence has not yet been severely shaken by the too rapid growth of selfish individualism, it appears to work smoothly enough. In the fixing of the quota payable by each family account is taken—as in European Russia—not only of the area and quality of the land held, but also of the general circumstances of the family, income from other sources, number of hands working the land, number of mouths to be provided for, &c., thus giving a large measure of elasticity. The *volostnoy* is the native official primarily responsible for the collections. Through the *starshinis* or village elders he realises from the village communities, and by the end of December must pay the amount into the subdivision treasury receiving a remuneration of about £100 a year for his trouble, paid by the people as an extra cess. In case of default or deficit in any household, the *volostnoy* or *starshini* makes it good from his own pocket, receiving a charge on the property of the defaulter or rather on the next crop. The collections are made only once a year, after the autumn harvest, in October, November, and December. Three months more are given for clearing up the subdivisional district and provincial accounts, but in Turkestan, under the present efficient administration, the accounts are usually closed by the end of January. I regret that I am unable to give any trustworthy figures of the total collections, and the incidence per cultivated area or per head of the population.

As far as I could learn, cultivated irrigated land is, for purposes of assessment, divided into six classes, the lowest paying only 50 copecks, or about 1s. 1d. per acre, and the richest and best situated in the neighbourhood of towns as much as 9 roubles or about £1. The Governor of Samarkand informed us that the rich rice and garden lands around that city generally pay this rate. The crops are similar to those grown in Transcaspia and Bokhara, but the soil is richer and the cultivation better.

Common property, which is the rule in Transcaspia, is the exception in Turkestan, and periodical redistribution seems to be unknown in practice. This, no doubt, encourages individual effort. Alienations by sale and mortgage to Jews, Hindus, and outsiders generally are prohibited by native custom and Russian administration. Alienations are allowed among Mohammedans, but only within the tribe and subject to the Mohammedan law of pre-emption.

There is not very much wheat grown, but rice, cotton, maize, mulberries and vines are very productive. The abundance of irrigation around Samarkand and Tashkent has much stimulated the growth of rice, but owing to its evil influence on the public health, its growth in the vicinity of these towns was prohibited some years ago. However, the agriculturists complained that the land would not grow any other crop, and after three years the prohibition had to be removed. Very fair wines are made at Samarkand and Tashkent, and are sold at from 6d. to 1s. per bottle, and there are several breweries at both places, but they have not yet succeeded in brewing beer at Askabad.

An attempt to grow tea has failed, as the young plants were killed by the severe winter frosts. Fruits of all kinds—apples, pears, peaches, plums, cherries, almonds, walnuts, pistachios, and *alu Bokhara* flourish here with a profusion only equalled in Kashmir. The most common trees are the poplar, willow, and wild mulberry. The rainfall is only eleven inches at Samarkand and ten at Tashkent. It falls chiefly in the spring months, March and April, and in the autumn, September to November. The temperature at Samarkand is moderate according to the Indian standard, rarely exceeding 95° in the shade. The heat is much tempered by the shady avenues which are such a feature of Samarkand and Tashkent, and at the end of April one could walk about freely during the day without feeling the need of any special protection for the head. The summer months and the early autumn are, however, decidedly feverish and unhealthy, and close to Askabad, Samarkand, and Tashkent there are sanataria in the neighbouring hills to which the chief officials resort. Turkestan exports wool, hides, and cotton in large quantities, and imports machinery and manufactured goods. Most of the cotton comes from Ferghana, which is estimated to export about 30,000 tons annually. This is brought to the railway at Samarkand on the shaggy, double-humped Bactrian camels. In the first thirty miles out from Samarkand we must have met between 3,000 and 4,000 of these camels laden with cotton. They seem to be hardier and more enduring than our Indian breeds, and each carries on an average about 6 cwt. or 40 per cent more than the Indian camel. They march two stages of twenty versts or about thirteen miles each, one in the morning, one in the afternoon. The cotton is exported chiefly to Moscow or Nijni Novgorod, where it is manufactured and part of it re-exported to Turkestan in the form of piece-goods. The Governor of Samarkand informed us that these would be driven out of the field by the cheaper and better finished products of the Manchester looms were it not for the prohibition tariff with which Russia protects her home industries.

Some years ago an attempt was made by local capitalists to start cotton mills in Samarkand and Tashkent, and thus save the enormous cost of sending the raw produce 2,500 miles off to be manufactured. The jealousy of Moscow — which, as General Count Rostovzeff aptly remarked, stands in the same relation to Samarkand as Lancashire to Bombay—was, however, aroused. The Moscow manufacturers brought their influence to bear on the Finance Minister, and succeeded in having the nascent industry prohibited at least for a certain number of years.

A striking feature of Turkestan is the enormous animal wealth possessed not only by the nomadic Kirghiz and semi-nomadic Uzbegs, but also by the Tajiks, Sarts, and settled Uzbeg population. The wandering Kirghiz are the largest owners, and have enormous herds of camels, sheep, and horned cattle. The cattle are larger and stronger than the ordinary Indian varieties. The Uzbegs are the chief horse breeders. The Turkestan horse is rather disappointing. They are rarely above 14·2 in height, and have a weedy look. Grey is the predominant colour. Their heads are very badly set on—most of them are what we should call ewe-necked—they are light in the bone, and do not seem to possess much strength or draught power, though their endurance is wonderful, and comes probably from the Arab strain, from which they probably also derive their good carriage and action. In Transcaspia and Turkestan every native is mounted on some kind of an animal. It is only Russians and other immigrants that one sees on foot. The Russians have thus a splendid store of camels, horses, and oxen to draw on for transport purposes in case of war.

On our way to Tashkent we came upon about 1,000 Uzbeg horsemen, who had collected for their national games, and among the horses there were few which seemed to come up to the standard of the Bengal cavalry. Their saddles and stirrups were light and sensible more like the English than the Indian pattern, but the bits had the cruel spike of the East.

The great waterless uncultivated plain lying between the Valley of the Zerafshan and of the Syr Daria on the road from Samarkand to Tashkent is known as the "Hungry Steppe," but when we crossed it at the end of April it was covered with a carpet of rich green grass and numberless flowers and plants, prominent among which was the long green stalk and yellow head of the assafœtida plant.

The plain was dotted with the kibitkas of roving Kirghiz and Uzbegs, and thousands of cattle and horses were to be seen grazing about in all directions. The grass which springs up after the melting of the snows and the spring rains is burned up by the heat of May, and in the summer months the once verdant plain changes into a bare treeless and waterless desert, well meriting its appellation. The nomads then retire with their flocks and herds to the cool mountain pastures, returning again in the autumn if there has been sufficient rain to make the grass shoot up.

The soil of this steppe appears to be equal to that of any of the Doabs of the Punjab, and needs only canal irrigation to be converted, as the Beri Doab and Rechna Doab have been, into a broad sheet of rich cultivation. Something has been already done to open it up by inundation canals from the Syr Daria, but these are on a small scale, and only touch the fringe of the prairie. The Grand Duke Constantine Nicholaevich, who is under a cloud, and lives in semi-exile at Tashkent, has taken up the irrigation question very ardently, and schemes have now been worked out, which, when carried out, would bring the waters of the Syr Daria into the very heart of the steppe; but for some years to come, there is little hope of funds being allotted for their execution. All the available funds are being devoted to the extension of the Transcaspian Railway to Tashkent and Ferghana, and to the strategic lines along the Khusk and Oxus in the direction of Herat and Afghan Turkestan respectively. In Turkestan and Transcaspia everything is subordinated to military considerations, and prosaic but profitable schemes of canal extension are elbowed out by more showy or ambitious railway projects.

The route from Samarkand to Tashkent—200 miles or so—has been fully described by Mr. Curzon. The alternation of steppe with river valley and lofty plateau breaks the monotony of the weary journey in a shaky *tarantass*, over what, at the time of our visit, was, owing to the heavy recent rains, one of the most infamous roads that it has ever been my misfortune to travel over. The fording of the Zerafshan, the railway bridge over which has not yet been opened; the crossing of the Syr Daria in an immense ferry boat that would hold a whole battalion, and is worked on the pulley system, by a rope attached to a series of boats moored up stream; and the fording in six places of the rapid river, which pierces its way through the historic part known as the Gates of Tamerlane, lend interest and excitement to the journey.

All these are needed to compensate one for the troubles of the road. The posting arrangements are in the hands of a lady contractor in Tashkent, who receives a considerable subsidy for the carriage of the mails, but who does not seem to consider herself under any obligation to provide a sufficient number of horses for passengers, though the latter pay handsomely for the privilege. Officers travelling on Government service have the first call on horses, and the result is that at each one of the frontier changing stations between Samarkand and Tashkent, a motley crowd will be found huddled together in the one or two common rooms, patiently or otherwise waiting till the official in charge, generally a surly moujik, sees fit to provide them with horses to continue their journey. Three horses harnessed abreast (*troika*) are required for each conveyance, and as the number of horses is far too few for the calls on them, the waits are long and weary. On our way to Tashkent we were detained for periods of three hours, nine hours, twelve hours, three hours, at various changing stations, and the journey, which can be covered in 21 hours, took us three days and three nights, though we pushed on at night whenever horses were available. The stock of provisions we had brought with us ran out on the way, and we had to fall back on the black bread and eggs which could be procured from the post-masters. The latter, even when they have horses available, are fond of meeting the demand for them with a decided "No," so as to compel the traveller to have recourse to the persuasive force of a *douceur*, or at least to while away the hours by calling for tea and a samovar. The unfortunate passengers grumble, complain, and submit. As is the case almost universally in Russia, natural indolence or a too slavish respect for authority prevents any one from taking active steps to remove a grievance which everyone feels. Our experience may have been exceptional—I trust it was—as the shocking state of the road was partly due to the recent abnormal rains, and the detentions on the road were a result of the great number of officials and native representatives hurrying Moscow-wards for the Coronation. At all events, the piteous recital of our woes to the Vice-Governor at Tashkent — the only civilian holding a post of any importance whom we met in Asia—moved him to kindly facilitate our return journey, with the result that we got back to Samarkand in 38 hours, passing on the way some unfortunate travellers whom we had already met on our way to Tashkent, and who were evidently resigned to losing a week over a journey which, with proper postal arrangements, should be accomplished in a day.

Tashkent, the capital of Turkestan and the largest city in Russian Asia, was occupied by Russia in 1863, when the Khanate of Khokand was conquered and annexed. It has nothing remarkable about it but the mud, which was far worse than even in Lahore after the winter rains. We entered it on a raw damp morning towards the end of April, through the usual dense masses of foliage, long avenues of tall poplars, and numberless gardens of fruit trees. It lacks the picturesqueness of Samarkand, but a fine range of blue mountains to the south, with snow-capped peaks, gives variety and colour to the landscape. The Russian town, as usual, is quite separate from the native city, and in the regularity with which it is laid out, and the large space it covers, reminds one of a huge Indian cantonment. The shops are mainly in Russian hands as in Samarkand, but on a larger scale. The only sights are the Governor-General's Palace, an unpretentious building, with a magnificent garden containing specimens of all the flora of Central Asia, the cathedral opposite it, and the military club, the centre of the social life of the place. There are several beautiful gardens, in one of which was held last year a Central Asian exhibition.

The native city has little to interest one beyond the labyrinth of quaint covered-in bazaars, and a number of handsome mosques with richly-decorated ceilings, and columns of ornamental wood-work. We waited on the Vice-Governor at his office, and saw something of the manner in which official business is transacted. A crowd of native petitioners was in waiting. The petitions must be written in Russian, but no stamps are attached, and as few of at least the leading officials are acquainted with the vernacular, the petitioners are questioned through interpreters. Among the petitioners were a Sart woman, whose close black veil gave her an uncanny and witch-like appearance, several applicants for passports, and an unsuccessful candidate at the recent triennial elections, who wanted to make out that his rival had succeeded through corrupt practices. This reminds me of the fact that some of the officials regard the elective system as a mistake, unsuited to the wants and habits of the people, and forced on them from above. They complain of the difficulty of working a secret ballot among an illiterate and partly nomad population, and of holding regular elections. Every adult male over 25 has a right to vote. Another source of complaint is that some of the Mohammedans are now embracing Christianity for interested motives, and developing intriguing tendencies. The natural genius of the Oriental for intrigue seems to flourish as freely in Central Asia as in India, and in both countries is most marked among the town population. Our return journey to Samarkand and thence to the Caspian was not marked by any special incidents.

RUSSIA AND INDIA.

Any remarks on Central Asia, however superficial, would be incomplete without some reference to the question of the possibility and prospects of a Russian advance on Afghanistan or India. The subject is one that as a civilian I feel a certain diffidence in touching on, and will, therefore, confine myself to what I believe to be a common, if not the general phase of feeling on the subject in Russia generally, and especially in Russian Central Asia.

During one's stay in Russia, and particularly when travelling, one continually comes into contact with the military element, which is by far the strongest body of anything like organised public opinion in the empire; and as Russian officers are generally frank and free in the expression of their views, and almost invariably in talking with an Englishman bring the conversation round to the questions at issue between Russia and England, it is not difficult to get at their general ideas on the subject of India, which, however, may and perhaps are totally different from the views of the Administration.

Further, educated Russians, being practically debarred from discussing internal politics, devote all their attention to foreign affairs, in which England to their minds after Russia plays the leading part, and are as a rule ready and willing to air their views without concealment. As regards the conquest of India, the matter may be put most clearly in the three following questions—(1) Do the Russians regard the conquest of India as feasible? (2) Do they regard it as expedient and desirable? (3) Are they anxious to take early steps to try and bring it about? By Russians, of course, I mean the average educated Russian, civil or military.

As regards (1) the Russians appear to think that the conquest of India by Russia is quite feasible. The Russians as a people have a decided leaning to visionary magnificent schemes, in this respect being at the opposite pole of thought from the British, who rarely take up a scheme till they have well weighed it and assured themselves of its practicability. The conquest of India is one of such schemes. They have also a strong conviction that all Asia must eventually fall under their influence. This conviction is based partly on the success which has hitherto attended their arms in Asia, successes which may easily be exaggerated, for it must be remembered that the Turkomans, the only really hostile tribe with which they have yet come into collision, do not number more than 250,000 souls, and that the total number of the conquered nationalities in Central Asia does not exceed four millions, or, if Bokhara and Khiva be included, seven millions.

However, what they see is that China, Persia, and the Asiatic Provinces of Turkey are practically at their mercy, that the way is open for them into Afghanistan through Herat, which is like a ripe plum ready to fall into their hands, that the Afghans, greedy of the spoils of India, would make common cause with them, and that once masters of Afghanistan the way is clear for the invasion and conquest of India, which is necessary in order to complete their mission or destiny. They look on the successful invasion of India as a not very formidable task, for they believe that the native populations are sick of British dominion, which, for its own evil and selfish ends, in keeping them in dark ignorance, and squeezing out of them all it can, has reduced them to the lowest depths of poverty. They further cherish the illusion founded on what they have heard and read of the Mutiny, that the native army is still composed of only the same elements as in 1857, and that its loyalty is not to be relied upon, that in any case it contains no good fighting material, and would never stand up to a European foe. Of the existence of the Sikh, Gorkha, Pathan, Panjabi Mohammedan and Rajput regiments, which now form the flower of our native army, they have heard nothing, or, if they have, do not believe it. Finally, the nervous apprehension of Russia with which, with some show of reason, they credit us in India, lead them to believe that we ourselves feel our position there to be extremely insecure, so that any shock from outside would shake it to the very centre. The British army in India, they admit, might be a difficult nut to crack, but they consider that the British soldier is pampered, insubordinate, and impatient of discipline, and in a long and weary campaign would be unable to hold out against their hardy Cossacks, inured to hardships and privations.

These views, which to us, or to any unprejudiced observer acquainted with the real facts, are full of the crudest fallacies and misapprehensions, are unfortunately held by nine out of ten average educated Russians, and are arrived at by erroneously exaggerating every point which makes in their own favour, and shutting out from consideration all facts which weigh on the other side. The fact, however, remains that they regard the conquest of India as feasible.

The next question is do they regard it as expedient and desirable? They would hardly be human, they would certainly not be Russians if they did not. From the days of Alexander to those of Napoleon the conquest of India has been the dream of every great world conqueror. Since the rise of Islam it has been the aim of the successive Mohammedan tribes who won for themselves the supremacy of Central Asia. The Russians regard themselves as the legitimate successors of these Central Asian conquerors, and reasoning that what has been accomplished so often before by Arabs, Afghans, Mongols, Persians, can be accomplished again, they too have come to look on India as their goal. Their hard-won conquests in Central Asia have hitherto yielded them much honour, but little profit. The conquest of India would give them both the one and the other. They have, moreover, persuaded themselves into the belief that in conquering India they would be doing a service to humanity, by rescuing it from the selfish clutches of England; and ludicrous as this argument may seem to us, we must remember that we have often employed it ourselves—generously, no doubt—to justify conquest and annexation. The Russian moujik may be, and is, essentially a good-natured, easy-going and peace-loving individual, but educated Russians are extraordinarily patriotic and ambitious, and the successes which have attended their arms and diplomacy for the last twenty years have inspired them with the belief, that it is the destiny of the Slavs to expand in every possible direction up to what they style "their natural boundary." This includes India. They see, or believe that they see, the signs of decrepitude creeping over the British Empire, while their own is expanding with all the vigorous buoyancy of youth, and they proudly say "the twentieth century is for us."

Once satisfied, as I believe they are, that the conquest of India is feasible and desirable, the average Russian does not take long to convince himself that it is also expedient. Numerous as are the good qualities of Russians, as a nation and as individuals, extreme scrupulousness is not among them. In Russia, as in most countries, the enlightened selfishness which we term expediency is the mainspring of action. Moral considerations in political matters have been little developed, and have little weight, as the institutions of the country have stood in the way of the development of a free public opinion, independent of and often able to impose its will upon the Administration, and nations which, like our own, profess now and then to be guided by the "national conscience," are openly scoffed at for hypocrisy, which is supposed to mask some sinister deep-aid scheme. On the way from Odessa to Kieff I was once asked point-blank by a shrewd intelligent merchant, by what art we managed to hold India with so small a British army. My reply that I supposed it was because the natives regarded our rule as a just one, and did not want to change it, was received by the company with a polite though chilling silence, but even their natural courtesy was not proof against a—to them—absurd statement, and they soon with one accord burst into a good-humoured but mocking laugh.

With regard to India the average Russian sees only the gain, and does not reckon the cost.

(3) The last question is, assuming that the average Russian—"the man in the street"—regards the conquest of India as possible, desirable, and expedient, are they anxious to ake costly steps for its accomplishment? This s not so easy to answer. The Russians have ittle public opinion independent of the Administration, an habitual deference to authority, and at the present moment such implicit conidence in at least the foreign policy of their Government, that they can and will do very ittle to force the hand of the Government or directly influence its foreign policy. Germany and England are looked on by the people as heir natural enemies. There is little or no personal ill-feeling to the British, whose repuation for honesty in business matters stands higher than that of any other foreign nation; at he most they are regarded as cold, proud, and unsympathetic, but personally trustworthy. As egards the German, on the other hand, there is a strong and general personal ill-will, based partly on the superiority which their steadiness and method has given them in Russian commerce, partly on the feeling that they have too ong exploited Russia, and profess to look down on the Russians. Many Russians will ell you that a war with Germany would be more popular with the people: a war with England—involving an advance on India—with he Army and Administration. The Conservaive and semi-official press, at the head of which stands the *Novoe Vremya*, at present is ery hostile to England, and advocates an understanding with Germany, while the Liberal press, the leading organ of which is the *Russkiya Vedomosti*, leans rather to an understanding with England. The Press, however, is so completely under the control of the Administration, that a slight hint from headquarters would cause a marked change of front. For this reason press opinion, and the public opinion founded on it, counts for less in Russia than anywhere else in Europe. The feeling of the Army is, however, more permanent and important. A standing army of 850,000 men, with 50,000 officers representing every section of the educated classes, and not raised into a separate military caste as in Germany, but recognising themselves as an integral part of the population, cannot fail to become a powerful influence on the minds of the people. It would, therefore, be interesting to know what is the general feeling of the army. This, however, is almost impossible to ascertain, though it may safely be said that any one section of it would be in favour of a war which would give that section active service and opportunities of distinction.

Thus the garrison in Poland would favour a war against Germany; those around Kieff against Austria; the great Caucasus army, 250,000 in number, would be equally pleased by a movement on India, or into Turkish Armenia; while the 42,000 men in Transcaspia and Turkestan, who have now for 14 years been stagnating in inaction, are, of course, eager for the signal to advance on Afghanistan or Persia. Probably the prevailing feeling is well expressed in one of Skobeleff's memorable phrases "What does it matter with whom you fight as long as you get the fighting?" or, as they put it in Tipperary, more vulgarly, but not less forcibly, "When you see a head, hit it." Central Asian service in time of peace is irksome and monotonous. The Russian officer has not, or does not care to make for himself, the resources in the shape of shooting, polo, athletic games, exploring, &c., which to the British officer make up for the drawbacks of service in India. He pines for the gaieties of St. Petersburg and Moscow, and longs for the excitement of active service. Often have Russian officers said to me "Your army in India has continual opportunities for rewards and distinctions on active service. You always have a few wars on hand, now on the Afghan frontier, now in Chitral, now in the Sudan, while we are bored to death in inactivity. Our only chance of active service is a campaign against you in Afghanistan and India, and though we have no personal ill will against you, we are naturally anxious for it." Exaggerated accounts of the liberal pay and luxurious surroundings of our troops and administrators in India make them more discontented with their own lot. They have, for the present at least, reached their limit in Central Asia, and any forward move could only be made at the expense of Afghanistan or Persia, which, in either case, they believe would provoke a war with England.

The construction of two new railways along the Oxus and the Kushk towards the Afghan frontier, which has just been undertaken, they look on as an indication that the Government holds the same views. My personal opinion, then, which may not be worth much, being formed only on 10½ months' residence in Russia, is that the average educated Russian regards the conquest of India as feasible, desirable, and expedient, and that the majority of their class, including a large proportion of the Army, would like to see early steps taken to bring it about.

These views rest largely on an overweening confidence in their own powers, and an extraordinary misapprehension regarding our forces of resistance in India, in other words, on the Russians taking for granted not the actual facts, but what they would like to be the facts. Needless to say the Administration in all probability does not share in these misconceptions, but anything that could be done to enlighten the general ignorance as to the true position of things would probably conduce to the interests of peace. Asia is surely wide enough for both powers, and in the arts of peace Russia might learn much from what we have done in India, while we in India might with advantage study their methods of dealing with their conquests in Central Asia.

Whatever view we may take of the general foreign policy of Russia, we cannot but yield a tribute of praise to the firm, humane, and consistent policy which, within a few years, has introduced complete order and security into the wilds of Central Asia; to the masterly statesmanship which has changed warlike tribes and the fanatical town population into peaceable subjects of the Great White Czar; to the steady and well-directed enterprise which is gradually extending to these regions the blessings of science and civilisation.

DISCUSSION.

The Rev. HENRY LANSDELL, D.D., said as the author of the paper had been pointing out many of the places mentioned on the map, many things had bee recalled to his mind with regard to his journey in tha country, especially some which struck him as bein most unlike what one saw in any other part of th world. As he floated down the Oxus in 1882, h was much struck with the condition of the peopl and the way they lived as representing a sem civilised state of existence. In one part every man house was in the truest sense of the word his castl It was fortified and surrounded with walls, and i fact he was obliged to protect himself in that wa from the roving tribes around. Then, again, as physical curiosity, he might remark that havin crossed one large desert for 13 or 14 days, seein neither man, woman, or child, when they got ne to the Caspian they came suddenly to the top of deep basin, and on looking over the edge he sa little hollows and mountains of chalk forming ev dently the bed of what had once been part of t Great Caspian Sea, and looking as fresh as if t water had only recently left it. When he went Bokhara in 1882, he had a letter from the Russi Government, and the Amir sent a deputation meet him. It was like going back to the days Solomon; there were half a dozen men on hors back in gorgeous robes, their horses magnificen attired, and after asking the stereotyped questio whether the Emperor was well, and whether t Governor-General was well, they formed a p cession until they came to the Amir, where th went through a number of old world ceremoni For three days he was kept in a sort of se custody, until he was summoned to see the Am and then he was somewhat puzzled as to how should attire himself for the occasion. The Russia told him that if he went dressed in his clergyma coat he would be taken for a Russian mercha and be thought nothing of; that their only idea o person of any importance was a man with number of medals, and a quantity of lace ab him. Then he remembered that the last Englishm in Bokhara, Dr. Wolff, nearly lost his life, attributed saving it to his wearing his gown and doct hood, carrying a Bible under his arm, and giv himself out as the great Dervish of England. thought perhaps it would be best to try combine a clerical and military appearance as far possible, so he put on his cassock, a gorge embroidered Servian waistcoat, and over that doctor's scarlet hood. Then he put on a vincial Grand Chaplain's Masonic collar, with a dozen Masonic jewels, and his college cap. afterwards mounted his horse and rode through streets, producing a great effect. Bokhara was t a most remarkable place. There was no printing pr no telegraph, and no post-office, and it was said the Amir read the letters of all his subjects before h them have them. He (Dr. Lansdell) wanted very m to go up to the top of the minaret, of which a view been shown, in order to be able to form an ide the size of the place, but he was told that the A had the key, and lived so many miles off, and though he used every form of persuasion, he was unable to gain admission. With regard to the question of war, he had been in every important town in European Russian but one, and all across Russia in Asia, but he should find it very difficult to mention half a dozen things which led him to think that there were any designs of that kind entertained. On the other hand, he had seen both sides of the shield, for he had been through Kashmir and up to Quetta, and there it was a very different story. He did not pretend to be any authority on such a question, but he could only say he had never seen any signs of war preparations going on in Central Asia.

Mr. E. A. CAZALET said he had not travelled in this part of the world, except on the Caspian Sea and in Persia, but he should like to say a few words about Mr. O'Dwyer. He had had the honour to be invited by the Civil Service Commissioners to examine various English and Indian officers, who had studied Russian, and he had seldom come across a student more intelligent than Mr. O'Dwyer, who appeared to have made remarkably good use of the opportunities he had had of learning the language and studying the country. If he, Mr. Cazalet, recollected rightly, Mr. O'Dwyer beat the record in the marks he obtained and passed with flying colours. To an Englishman, like himself, who took a special interest in Russian questions, it was a satisfaction to examine intelligent officers who had travelled in these out of the way places in Russia and Central Asia. One of the questions he put to Mr. O'Dwyer in the *viva voce* examination was "What difference and what similarities he found amongst the natives of India and the Russian peasants or moujiks?" His answer was that the Russians had a much stronger feeling of nationality, which was greatly increasing; they felt they formed part of a vast empire. But the natives of India had a great pull over the lower classes of Russia in that they were not given to drunkenness. On one occasion when the speaker presided at the Anglo-Russian Society, a paper was read on the subject of trade between England and Russia, and though Mr. O'Dwyer was entirely unprepared, he gave off-hand a very interesting exposition of the strong and weak sides of our trade with Russia. He did so with the greatest discretion.

Mr. MARTIN WOOD said it was very interesting to compare the full and accurate account of Central Asia now given with the idea which many people had 20 or 30 years ago. The progress of knowledge among Englishmen as to Central Asia in that period was one of the most remarkable instances of the advance in modern knowledge. One knew generally, through the old travellers, the physical geography of the country; but now, from study of such papers as this, they would know almost as much of the people themselves, of the products and the climate, as they did of any country of Europe. The author had alluded to the bogey of the possibility of a Russian invasion of India, and perhaps that was the most interesting part of his paper, especially as he had gone into it from the Russian point of view. They knew that even some of the best Russian strategists, as they considered themselves, such as Skobeloff, had the most wonderful ideas as to the possibility or practicability of an armed invasion of India; though, in these days of gunpowder armies, such an undertaking would break down with its weight. He suggested that it would be very useful if this portion of the paper at least were translated into Russian and circulated in Russia, or, at any rate, if it got into the hands of men responsible for the policy of that country. The Chairman knew better than most people what were the bearings of those physical conditions attaching to the mountainous regions, and the barren deserts of Central Asia, and no doubt appreciated the difficulties, not to say impossibilities, which would beset any invasion of India from that side. The paper showed the advantage possessed by an Indian revenue officer in treating such a subject.

Mr. M. M. BHOWNAGGREE, C.I.E., M.P., thought it would be more useful if this paper could be translated and circulated in India, for he must say the idea which he gathered from the concluding portion of the paper did not at all tally with that of the last speaker, who assumed that it showed the Russian mind realised the impracticability of invading India. He thought it rather tended the other way, as it showed that the hope of the educated as well as the militant Russian was some day to make India a Russian province. Turning to India, however, they all knew that the Indian mind of to-day, to the superficial extent to which English education reached it, was inclined to believe that the English government of India was unsympathetic and oppressive, and that almost any other government, Russian included, would be a relief. The concluding portion of the paper would be very useful in giving the right impression as to the beneficial system of English rule in India, as compared with what the Russian Government would be capable of doing. He had been much interested in the history now given of the provinces under Russian rule, and he was quite sure after hearing it, that the English Government need not be ashamed of the comparison. The English Government had adopted methods which tended to give civilisation, liberty, and enlightenment to the vast masses of India, and a paper like this, if widely disseminated there, would do a vast deal of good, and, at any rate neutralise the mischievous sentiments which were to-day being disseminated through the British agencies he had alluded to in the minds of the people of India.

The CHAIRMAN said the very picturesque statement at the end of the paper had, he thought, rather drawn them away from its main scope, for this military question, which had arisen in a very natural way, was not the most important part of it. Dr. Lansdell had rather anticipated what he was going to say on that question. They must not attach too much importance to the fact that Russians had built railways in Central Asia. It would be impossible to administer a country of that kind, unless they had some assured means of communication, and he gave them credit for great foresight in building railways not altogether for military purposes. Dr. Lansdell had pointed out that though he had travelled a good deal about the country, he could see no sign anywhere of the formation of military strongholds from which armies could be launched against India. They knew the strength of the entire forces employed by Russia in Central Asia, and it was very moderate; in fact, it was wonderful how they managed to administer the country with such a small body of troops. He was sure they would all join in giving a hearty vote of thanks to Mr. O'Dwyer, and hoped the Secretary would communicate to him how extremely delighted they had all been with the admirable way in which he had put the case before them. It must be remembered that he came into contact only with the military classes in Central Asia, and their conversation would naturally turn on military questions. Still that was only brought in as a picturesque ending to a paper which was very useful and interesting in other respects.

The vote of thanks was carried unanimously, and the meeting adjourned.

Mr. HERBERT S. JONES, who in 1892 read before the Indian Section a paper entitled, "From Tian Shan to the Pamirs: Experiences on the Russo-Chinese Frontier," writes that had time permitted he should like to have said a word or two in support of Dr. Lansdell's very apposite remarks on the subject with which Mr. O'Dwyer's paper concluded, and in reference to the difficulty of ascertaining the real opinion of the Russian Administration from individual expressions of opinion by Army officers or others, and still more from the Russian Press. Mr. Jones recommends an impartial consideration of the action of the Russian Government in regard to the Kashgar State, and the retrocession of Kuldja.

Correspondence.

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HISTORICAL AND PRACTICAL CYCLING.

There is one bicycle not mentioned by Mr. Hillier in his interesting paper, that it may be worth while referring to in connection with the evolution of cycles. I call to mind one that was made for the late Hon. Ion Keith Falconer while he was at Cambridge. It was in 1874 or 1875 when the front wheels were getting bigger and bigger. Though a very tall man he could not get one large enough to suit him without gearing, so he had a seven-foot wheel made, which was driven by a connecting rod running down the side of the fork. I do not think, however, that it was considered a success, as the friction of the gear more than counter-balanced the advantage gained by the large wheel. It certainly was not convenient, for though an expert rider he could not mount or dismount without propping the machine up against a wall. In no sense could it be called "a safety."

WILSON NOBLE.

Sissinghurst Grange, Cranbrook.

MEETINGS FOR THE ENSUING WEEK.

WEDNESDAY, APRIL 21...Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. W. H. Dines, "The Relation between Cold Periods and Anticyclonic Conditions of Weather in England during Winter." 2. Mr. A. B. MacDowall, "Sunspot Influence on the Weather of Western Europe." 3. Mr. A. Lawrence Rotch, "The Use of Kites to obtain Meteorological Records in the Upper Air at Blue Hill Observatory, Mass., U.S.A."

Microscopical, 20, Hanover-square, W., 8 p.m. Exhibition of Microscopical Entomological Specimens by Mr. F. Enoch.

Archæological Association, 32, Sackville-street, W., 8 p.m.

THURSDAY, APRIL 22...Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. W. C. Tyndale, "House Drainage."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. A. K. Baylor's Paper, "Recent Developments in Electric Traction Appliances."

Historical, 28, Jermyn-street, S.W., 5 p.m.

FRIDAY, APRIL 23 ... Antiquaries, Burlington-house, W., 2 p.m.

Philological, University College, W.C., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

SATURDAY, APRIL 24...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

CORRECTION.—Mr. Barraclough sends the following correction of a passage in his remarks printed on p. 438, col. 1:—*For* "His invention was not in the machine but in the fibre. No doubt other machines would be invented which would do more than Faure's," *read* "His interest is not in the machinery but in the fibre. No doubt other machines may be invented which might do more than Faure's."

Journal of the Society of Arts.

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FRIDAY, APRIL 23, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The fourth meeting of the Congrès International de l'Enseignement Technique will be held this year in London, commencing on the 15th of June next, at the invitation of the Society of Arts, and of the Worshipful Companies of Drapers, Fishmongers, Goldsmiths, Merchant Taylors, and Clothworkers.

The Congress will be opened at 11 o'clock, on the 15th of June, by an address from the President, the Duke of Devonshire, K.G.

The subjects for discussion at the Congress will include :—

Technical Education :—

1. Advanced Instruction. Polytechnics, Universities, Colleges.
2. Secondary Instruction. Higher Technical Schools ; Secondary and Intermediate Schools ; Evening Schools.

Commercial Education :—

1. Advanced Instruction. Colleges ; High Schools and Institutes of Commerce.
2. Secondary Instruction. Commercial Schools ; High Schools ; Classes for Adults.

It is not proposed to deal with elementary Technical or Commercial Education. The education of both sexes will be included. Further information will be issued at a later date.

The Executive Committee will be glad to receive offers of papers coming within the scope of the subject as above defined. The papers must be in the hands of the Secretary not later than the 29th May.

The papers will be printed and distributed at the meetings. They may be in French, German, or English, and speakers may make use of any of these languages.

All communications relating to the business of the Congress should be addressed to the Secretary, Society of Arts, John-street, Adelphi, London, W.C.

PRACTICAL EXAMINATIONS IN MUSIC.

The Practical Examinations in Vocal and Instrumental Music will be conducted by Mr. John Farmer, Balliol College, Oxford, and Director of the Harrow Music School, Examiner, and Mr. Ernest Walker M.A., Mus.Bac., Oxon, and Mr. Burnham Horner (organ), Assistant Examiners, at the House of the Society, and will commence on Monday, 28th June.

Particulars can be obtained on application to the Society.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, April 6, 1897; Augustus Helder, M.P., in the chair.

The Chairman, in introducing Mr. Fripp, referred to his great experience as a traveller, he having been at the Cape in the Kaffir war of 1878; again in the Zulu war in 1879; in the Transvaal war in 1885; in the same year in the Soudan; in 1889, on a tour round the world; in 1895, in the China and Japanese war; and, in 1896, in Matabeleland and Mashonaland, which he was now going to describe. His abilities as an artist were well-known, and he had been elected an associate of the Royal Society of Painters in Water Colours, on account of his Japanese sketches, so that they might anticipate a thoroughly interesting paper.

The paper read was :—

RECENT TRAVELS IN RHODESIA AND BRITISH BECHUANALAND.

By C. E. Fripp, A.R.W.S.

For the benefit of those members of the present company who may not have enjoyed opportunities for the study of the physical features and history of those parts of South Africa which form the subject of this discourse, I propose to state a few facts as briefly as is consistent with essential lucidity.

At a distance of less than 150 miles from the southern coast, the great central plateau of the South African continent may be said to commence with the plains of the Northern Karroo, a Hottentot word denoting " dry or desert." It is a very appropriate name, for the main characteristics of a desert predominate in the Karroo, which, spreading eastward and northward across the Orange Free State and a great part of the Transvaal, stretches past the border of the last-named country to the north as far as the Zambesi, attaining an altitude varying between 3,000 and 6,000 feet.

Bechuanaland, commencing north of the Orange river, is part of this great plateau, and includes the Kalahari desert as well as a great extent of the depression, where Lake Ngami with numerous marshes and salt pans indicate the former existence of a vast inland sea once receiving the waters of many rivers from the north, east, and west. At the present day, however, the principal characteristic of this enormous area is a lack of water varying, of course, in localities, and with indications that the climate is gradually becoming drier. The annual rainfall in the western districts is said to be 10 inches (about the same average as the Karroo, some parts of which average but 2 inches annually), and according to one authority I have consulted, an average of five years taken near Vryburg and Mafeking on the eastern border, gave an annual fall of 30 inches.

The boundaries of Bechuanaland are now distinctly traced on the north by the Zambesi and Chobe rivers, on the west by the German territory of Namaqua-Damaraland, south by the Cape Colony, east by the Transvaal and the territory of the British South Africa Company.

It appears that the Bechuanas were first described living north of the Orange river by some Namaquas (Hottentots) visiting Cape Town in 1681, but that great river was not actually discovered until 1778, by a Colonel Gordon in the Dutch service, who, in honour of the Stadtholder, re-named it the Orange river, it being otherwise known as the Gariep. The Bechuanas themselves came prominently into the history of South Africa in a very uncomfortable manner, about 1830, when they were invaded in the land north of the Vaal by Umziligazi (otherwise known under the corrupt form of "Moselekatze"), a Zulu chief who offended his king, Chaka, about 1826, by unlawfully disposing of captured cattle, and deserted with his men of the Amandebele tribe to escape the consequences; thus he fell upon the peaceful Bechuanas, and established himself as an independent chief at Mosega, but in 1836 a new aggressor appeared, and Umziligazi was in turn attacked and defeated by the Boers; Dingana, too, Chaka's successor, sent forth armies to attack the delinquent Amandebele, who, to evade further onslaughts, retreated north, across the Limpopo, where, by the subjugation of the Mashonas and Makalakas, Umziligazi anew founded a home for his tribe, now generally known under the corrupted name of Matabele.

As the natural sequence to the invasion of the Boers, many Bechuana tribes came under the sway of the two Dutch Republics, the Orange Free State and the Transvaal, yet not without disorder and bloodshed, in which the musket generally proved a stronger argument than the assegai, though there have been occasions when the Bechuanas, generally alluded to as peaceful, have fought hard for their independence and soil, as also did the Bapidi, under Sekukuni, in 1876, and particularly the Basutos (who are not pure Bechuanas, but consist largely of Kafirs who fled before Chaka's armies), who for years resisted the encroachments of the Orange Free State, even to the last gasp, and who, in 1880, were successful in resisting the not over-daring military operations of the Cape forces.

But Bechuanaland may be said to have come, for the first time, under the direct notice of the British public in 1884, when Boers, principally from the South African Republic, encouraged by the events of 1881, and the supineness of the Imperial Government, had, since the last-named year, been undertaking filibustering expeditions into the territory of their native neighbours, and founded two small states, named respectively Stellaland and Goshen. In about three years, the Imperial Government was actually stirred to action, which, taking the form of an expedition of 4,000 men, mostly irregular horsemen, under Sir Charles Warren, was successful in causing the intruding freebooters to retire without offering resistance, and the South African Republic withdrawing a proclamation annexing Montsioia's country, order was restored. I may add that this force, composed mostly of young Englishmen accustomed to ride and shoot, was the most effective force for South African warfare that the British Government has hitherto employed.

This was, however, not the first attempt of the Transvaal burghers to possess themselves of Bechuanaland, for although the republic was then in the state of collapse, due to misgovernment (which brought about the annexation by the British in 1877), President Pretorius, in 1868, declared the western boundary of the Transvaal to extend from Langeberg to Lake Ngami, but the Imperial Government wisely refused to acknowledge the validity of this proclamation.

The policy of our rivals to supremacy in South Africa was, both in 1868 and in the early eighties, obviously to close the only route northwards by which British trade and influence might hope to expand, yet the Imperial Government failed to acknowledge the importance of Bechuanaland until 1884, when a Commissioner named Mr. Rhodes was instrumental in emphatically calling attention to the hostile acts of the freebooters directed against natives under British protection. The results of the action of the British Government were the creation of the Crown colony of British Bechuanaland (which in 1896, became merged into the Cape Colony), followed by that of the Bechuana British Protectorate —still under Imperial administration.

It should be remembered that just at this time the Germans were allowed to acquire the Namaqua-Damaraland territory north of the Orange river, and had the attempt of the South African Republic succeeded in drawing a line across South Africa to the German boundary, the consequences would have been serious; the occupation of Mashonaland in 1891 by the British South African Company would have been forestalled by the Boers, who, as it has happened, have found themselves debarred from northern expansion, as they had hoped to debar the British. This step being also initiated by Mr. Rhodes, he fully earned the hatred of Mr. President Kruger, who yet was wise enough to discountenance the Boer filibusters' attempted raid into Mashonaland in 1891.

In May, 1896, I found British Bechuanaland to be suffering from the effects of drought, locusts, and rinderpest, the last-named scourge having just begun to make its way into the north-eastern district in spite of the cordons of special police guarding the northern boundary for a distance of 150 miles, the Transvaal border for 250 miles, and the Vaal river in the south. So far as cattle conveying the pest were concerned, this system of cordons, formed by patrols of six or seven men placed 10 or 12 miles apart, might be considered fairly efficacious, but the germs of disease appear to be so easily spread by wild animals, birds, insects, and the wind, that the means adopted could hardly hope to do more than obstruct the progress of the epidemic.

On a tour of investigation, I noticed the effects of drought and locusts in the fields of shrivelled stalks of maize and millet grains known in South Africa respectively as "mealies" and "Kafir corn". The locusts we sometimes saw hanging on the bushes in thick brown clusters, or blown about like dead leaves by the morning wind as they dropped in alarm at our approach. Water was found in pools in the dry beds of streams, in circular pits, and in vleis (large shallow ponds), usually many miles apart, and not in great quantities; but we had several thunderstorms which refilled the shrunken pools to some extent by heavy falls of rain, which unfortunately came out of season for the crops and pastures.

Farmers are numerous along the Vaal river, but their homesteads become rapidly rarer objects on the vast bush-dotted plains as one travels northward. The soil is mostly red and covered with grass, resembling what is called "bunch grass" in the States, affording excellent pasturage as a rule for goats, sheep and cattle, small flocks and herds being occasionally seen.

It is claimed that fruit, vegetables, and all kinds of cereals can easily be raised by irrigation, the maize and millet cultivated by the natives yielding good crops in good seasons. This was the invariable description of the agricultural resources in most parts of South Africa, given me even nearly twenty years ago; nevertheless, at the present day, with the exception of a few parts, the States of South Africa appear to be as insufficiently supplied with agricultural produce as on my first visit in 1878. The natural advantages of agriculture in South Africa are, like the water, not always on the surface.

So in British Bechuanaland the soil may be good in parts, but the rainfall is precarious, and locusts may invade the crops when flourishing; also it is doubtful whether the farming class possess the thrifty energy of the settlers farming in Manitoba, who in a few years produce a surplus of wheat for export; whereas in South Africa, wheat is imported in large quanties to the present day.

As for the results of irrigation, it would be judicious to postpone opinions until something is introduced on such a scale as has succeeded in Australia and America.

Last year in May, Mafeking, close to the northern border (where old Montsioia, whom the British Government rescued from the clutch of the Dutch Republic in 1884, died recently much mourned, for he was much married), was the railway terminus, and a very uninviting place it appears coming from Cape Town, particularly when you arrive there in the small hours of the morning to discover that the inns or hotels are full, and that the only entertainment is to sit on one's luggage in the yard and watch two cats and a sick hen till daylight. To have to sleep for some nights on the floor of a little room with two other men when there was only decent accommodation for one bed, one companion with a touch of malarial fever, the other performing astonishing duets through his throat and nose, was rather unpleasant, but it was even more disappointing to find that when one did get a bed, that the floor was much more comfortable. I must do the host justice and say the food was wholesome.

Although I was in great haste to get away to Rhodesia, nearly a fortnight was spent in Mafeking, where horses and everything connected therewith were at a premium. At last, however, I procured a team, a travelling wagon on four wheels, had harness sent up from Kimberley, and the old vehicle was loaded up with oats and mealies for the horses, and with several months provisions for myself, the driver and a boy. The driver, Harry, a coloured man of St. Helena, was a very good fellow of his kind, for he only got drunk about three times in the first week; the Kafir lad of fourteen years was intended to assist the driver, which he did mostly by sitting down.

So the outfit started one afternoon, but a wheel that had been repaired persisted in getting on fire, a circumstance occasioning three more days of delay; this came as a climax to a series of incidents characteristic of the slipshod methods prevailing, and it was with conviction that I wrote down Mafeking as a benighted hole.

At last we really did start on the 500 mile journey to Matabeleland, which under more favourable circumstances could not fail to have been a most pleasurable experience. For though the bush-clad waterless country is in many respects monotonous, the brisk air and bright sunlight at this season lend a charm peculiar to South Africa, the bush and grass are often stirred by a gentle and refreshing breeze, and it is easy to conceive the fascination the country must possess for the hunter wandering without definite goal to reach within a certain date. But at that time the route was in a disorganised condition in consequence of the rinderpest, and of the despatch of some hundreds of volunteers to assist in the repression of the Matebele rising, which, in spite of the assurances of the British South Africa Company's agent at Mafeking to the contrary, was still in full swing, the rebels yet holding control of the country within a short distance of Buluwayo. Besides, the native crops along the route had failed from drought and locusts, and the grain collected at the few stores on the road was reserved for the British South Africa Company and their transport; thus food for horses was almost impossible to obtain, and I considered myself fortunate in procuring a sack of mealies at Sequani, and two smaller sacks of mealies and weevils at Palapye.

Watering places, except when we travelled near the banks of the Marico and Limpopo, were scarce and far between (once 36 miles), which told heavily on the worn and underfed animals. At the ordinary outspan places, which were determined by the presence of water, the grass had been eaten away by transport animals, leaving at best mere pickings within a mile or so; therefore, when food ran short, we often made a halt to let the horses (of which there were five at first) feed on a good bit of veldt we might happen to come across. Nevertheless, the anxiety for the welfare of the poor brutes became no small burden; Harry, the driver, became greatly disgusted at such travelling, but proved to be a thoroughly useful man, willing and, above all things, *honest*—a qualification coloured drivers in South Africa are not generally credited with.

Signs of human habitation, after leaving the vicinity of the border dividing Bechuanaland and the Protectorate, became rare; and whites were only found residing in such places as Ramoutsa, Gaberones, Palla, Palapye, and Tati, until the border of Matabeleland was crossed. Whenever we halted near their settlements, although it was a pleasant change from the monotonous loneliness of day after day passed in the desert-like bush, their vicinity was not always an unmixed blessing; for the domestic animals, possessed of a ravening spirit in harmony with the arid wilderness surrounding them, seemed to pay particular attention to strangers: goats, pigs, dogs, fowls and ducks were so persistent, that we had to be un comfortably circumspect in our domestic arrangements in this land of famine, where onions were precious, the only meat (if any) was lean goat's flesh. Mules, too, were sometimes importunate invaders, with a clumsy way of putting their hoofs into pans and kettles, and had to be driven off to seek pastures new, in cases of emergency, with the flat of a spade.

The natives, when met with in any numbers, were interesting to study. I was struck first by the absence of the dignified bearing which usually marks the Bantu race, and by the importunate boldness, not to use a stronger expression, of the women. The men are attired in soiled or tattered European clothing, and look perfect scarecrows in their work-a-day garb, unless these defects are covered with a blanket; the women, who affect European attire, are not much better, and, when at work, like the men, do not hesitate to throw off any garment interfering with free movement. Etiquette is peculiar—perhaps these people have been taught that it is wrong to go out without a good deal of clothing, and therefore when within their own enclosures they think it quite proper to throw off their civilised "vermin nests." Some women, the young girls and children, adhere to the aboriginal attire of skins, beads, &c., which is becoming and appropriate to their method of life. It must be admitted, after seeing many decrepit and ugly nude forms among savages—human to be sure, but not markedly divine—that it is a proper æsthetic sense which prompts man to adopt an outer covering beyond his skin, but it may be suggested that though wisdom may have suggested covering for the human form, folly does much of the fashioning The way in which civilisation seems to have shed old European garments among the natives here has very little fitness, for, as regards appearance, the aboriginal skin skirts and karosses of the women so long as they live in small huts, are cleaner in some respects than European clothing.

The dwellings of the Bechuana are, so far as I saw, much alike; the hut is circular, low walls and floors well-made of terra-cotta coloured earth mixed with straw and cow-dung, the latter acting when fresh as a foil to noxious insects and the operations of the white ant; the pointed thatched roof projects beyond the walls into a forecourt, and supported there on posts forms a small verandah over the door, which is made of wicker fitted to slide into a groove in the wall, and is so low that it is necessary to stoop on entering. The forecourt, of an area exceeding that of the hut, is encircled by a loopholed wall meeting the ends of the verandah; the walls and floor are of the same material as the body of the hut, so that the inhabitants may squat and work comfortably, according to their notions. Not infrequently, the court-wall is decorated, outside the entrance, with large angular patterns in red, white, and sometimes dark blue. The large kraals are subdivided by groups of such huts surrounded by high wooden fences.

The Bechuana, and especially the Bamangwato, does not enjoy much of a reputation as a worker from white men. At the gold mining works of Tati, the Zambesi "boys" are preferred most, the Bamangwato least. Traders told me that they got on easier with the natives before British administration was introduced, a fact ascribed to an unsatisfactory system of justice.

A very ordinary case is as follows. A native is employed to work at a certain wage; he takes the wages, but does not work. The employer has no remedy, for if he refuses to pay the wages, the native goes to the magistrate or resident (I believe the latter is everything combined) who has the power to enforce the payment of the wages, but is not able to enforce the labour. If the native neglects to work, and is struck by the exasperated employer, the native goes to the magistrate, who has the power to enforce a fine. Besides in both cases the employer is, probably, compelled to attend court, at great inconvenience to himself, and none whatever to the native.

Besides having to procure permission from the chief where he proposes to trade, which has to be purchased, the trader has to pay for a license to the Imperial authorities; thus, he pays twice over. If natives steal sheep, or commit assault or other offences against the white men, the latter has no redress but to go to the chief, who, as a rule, says a good deal, but does nothing. An appeal to the magistrate is useless, for he says he has no jurisdiction. But if the white man steals from, or assaults the native, the latter *can* take the case before the magistrate, and the white man can be punished. The white trader goes to the magistrate for protection, but does not get it; the native goes and can get it. Why then has the trader to pay a double license?

My own experience of the natives is that they shun work, as does a Chinaman washing in winter. In vain have I offered the loafers, greedily eyeing my cooking-pot with their hands on their stomachs, money and tobacco, if they would undertake some such job as fetching wood or water, or watching the horses. Rarely did they accept my offer, or execute their part of the bargain if they did.

Khama's people, the Bamangwato, are looked down upon with contempt by Zulu and other Kafirs, who say "they are not men." Still, they seem capable of working for themselves: witness the wagons, clothing, ploughs, &c., which some of them possess apart from the cattle, of which some 90,000 had died of rinderpest when I reached Palapye on June 6th. The morality of the place enjoys an evil reputation, and it seems that conversion to Christianity is not so complete in practice as in theory. Indeed, the natural impulses of barbarians are not to be kept under control by moral persuasion suddenly succeeding the forcible measures to which they have been accustomed for generations. Khama himself in cases of emergency is said not to be averse from reverting occasionally to ancient methods, which may perhaps account for the control he exercises. The majority of his people by no means acquiesce in his theories of total abstinence, and had he not granted them liberty to drink Kafir beer (tywala), his tribe would have been greatly decreased by desertion. The authority of a Kafir chief is largely based upon the will of his people. Yet his efforts to prevent the introduction of spirits into the country, though not completely successful even in his capital, are prompted by a wise determination to prevent his people from following wholesale the pernicious and degrading example set by low whites.

The population of Palapye is considerable, consisting as it does of 37,000 Bamangwato and about 200 whites; the native huts in groups encircled by thorn fences, are of the same pattern as those of other Bechuanas, and cover a considerable area of a rocky plateau with northern aspect, sloping downwards to the Lotsani river, some six or seven miles distant. Khama lives in an iron-roofed brick building of the same character as the better dwellings and stores of the Europeans. From the large sandy place where the latter are located, there is an extensive view of the vast plateau rising gradually from the opposite bank of the river northwards — an immense bush-covered expanse skirted on the north-west by distant hills of a broken character.

After having traversed 400 miles of bush wilderness between Mafeking and Tati, a tract which only supports in a precarious manner a couple of hundred thousand head of cattle and half as many natives (for besides lung, gall, and other diseases to which cattle are liable, there is drought to fear, and locusts threatening to destroy the crops of maize and millet), the traveller is naturally impressed by the sound and sight of the steam machinery and mine workings which greet him at Tati. In June, 1896, there was a little population of 250 whites, and before the rinderpest and Matabele rising 1,500 natives were employed in the different mines in the Concession, which after years of vicissitudes and hindrances caused by invading Matabele, difficulties of transport, and the remoteness from civilisation, seemed about to enter into a state of prosperity. But this was not yet destined to be. Transport at the time I was there cost £100 per ton from Mafeking instead of £12 10s. Tea and coffee, horse food, meal, &c., could not be purchased; the only meat was goats' flesh, and that was scarce; eggs cost five shillings a dozen. On my return journey in October, I found that this state of things had resulted in the cessation of all operations. In the rainy summer season the river bed which I saw as an expanse of sand holding water in considerable quantities some feet below the surface, becomes filled with a turbid impassible torrent; fever is then rife, though less harmful than in the earlier years of the settlement, which improvement is attributed to the burning of the long grass and the partial destruction of the bush.

Beyond Tati the same monotonous bush continued to surround us, though it was somewhat more open in spots near Mangwe, which place was reached after nearly five weeks' journey from Mafeking on June 22nd.

Mangwe is a small fort of some importance in Matabeleland, situated sixty miles south-west of Buluwayo, and as my arrival here marked a period in my expedition, I propose to give a few details as to the manner of travel in these parts.

We usually rose well before dawn, lighted a crackling fire, put the nose bags on the horses, and sat by the fire over a hot cup of coffee and a pipe, to wait for the break of day; sometimes through the dull sound of the horses munching at their ordinarily scanty rations of mealies, a sound dear to the traveller who loves his animals, the distant yelps of jackals reached our ears. All else was silence around us, until there arose from the dark ring of bush the call of pheasants loud and shrill in the cold, still dawn, as the low moon sank majestically behind the twisted branches of a dead tree into the bank of cloud on the horizon. A faint grey light in the east spread slowly above the bush, and small birds began to mingle their sweet morning cries, one with a long plaintive note, but none like our home birds for richness of song. Then as grey dawn waned before the warming glow of sunrise, the wagon was repacked and well before the glorious sunlight slanted, sparkling through branches and sparse foliage, between the crooked stems, our horses were already trudging along the dusty track.

It seems as if nature has done so much for the tracks or roads in this country, that the authorities would regard it as an insult to her to offer much assistance. Of course, one cannot expect that a road through an unproductive wilderness of bush should be very well cared for, but a small expenditure judiciously applied would have vastly improved the highway, especially at the crossing places of rivers (named "drifts"), where the cuttings through the banks to the level of the bed are at such an angle that it is a question whether double spanning or off-loading may not be necessary; then there is no reason why the stumps of trees should have been left standing in the track, excepting that it was easier work for the chopping party, who by cutting down the trees have made the road. It seems a kind of tradition in South Africa that if a wagon strikes a big stone without climbing over it, the waggoner shall push the stone from under the wheel, but leave it in the road to encounter the next wagon. There are, moreover, portions of road where heavy sandy soil tells terribly on draft animals, the wheels grinding hard through the loose stuff which pours off them like water; for such places there can be no remedy.

All along, evidence of the rinderpest was only too apparent, and sensible to smell as well as sight, for in the bush and grass many carcases lay concealed from view; nevertheless, those we saw were numerous enough, sometimes lying together by the dozen in strange contorted attitudes and in various stages of decomposition; besides dead cattle, mules and donkeys, dead from overwork, starvation, and thirst, helped to pollute the air, and were often left lying in the middle of the narrow track, according to general South African practice, it being too much trouble for the driver to haul the carcase aside. Bush, sometimes graceful trees, but mostly thorns, was always round us, and often the track was hemmed in by scrubby bush, with stunted aloes showing in the dried grass or stoney soil. Along the dust ran small grey beetles with wonderful celerity, and vultures slowly soared in circles above spots in the thickets whence puffs of wind would bring pestilential whiffs.

It was always with a feeling of relief that the tired animals could be brought to a watering place; the necessary element, excepting when in the immediate vicinity of the Marico or Limpopo rivers, being found in the apparently dry sandy beds of rivers by digging in "pans," which are small circular depressions where rain has collected, and in pits made by man. Once we were compelled to water four horses by filling a bucket by means of a tin pannikin, with the water slowly oozing out of the sand at the bottom of a hole we had made.

One of my pleasantest reminiscences of the journey was a day's rest on the borders of a pretty vlei, whose waters were evidently shrinking. Surrounded by bush at an average distance of a hundred yards from the water's edge, the sight of a fair stretch of water after many days of scarcity invested the place with great charm. Early in the morning and late in the evening, numerous doves and small birds came flying to drink, and the quaint "hammerkops" remained picking amid the shallows all day; about noon small speckled herds of goats and long-tailed sheep came pattering out of the dusty bush, driven by small naked boys on to the open space, where they stood about on the light brown margin of the blue water, the fringe of bush, with distant hills beyond, helping to form a pretty picture; then strings of women and children came with pots balanced on their heads, the elders striding along with free gait, causing the leather petticoat to sway from side to side as they stepped along in file. Men, too, came in twos and threes, clad or partly clad in shabby European dress, seeking to refresh themselves with a drink and to repose beneath the shade of a bush afterwards during the heat of the day. They all seemed careful not to wash themselves in the pool; nevertheless they soaked evil-smelling cowhides in it. Some came and begged for tobacco, or sat watching Harry by the hour in the vain hope of being asked to take refreshment.

As the shadows lengthened and crept across the placid pool, the herds and people filed away to disappear in the darkening bush. Then in the dusk birds whirred past to and from the water's edge, till by degrees their calls and whistles died away. The heated air rapidly cooled, and one gladly drew near the clear red fire for warmth, supper, and a last pipe before getting between the blankets; then the strange cry of a night bird or the distant yelp of prowling jackals alone would break the silence of night, and the deserted pool would reflect but a starry shimmer from the heavens above, which, in former times, witnessed troops of antelopes, elephants, and other wild animals assemble for their nightly drink, undisturbed save by some solitary hunter seeking refuge from a remorseless civilisation, yet unconsciously becoming its pioneer.

The actien of the authorities in stopping wagons laden with supplies for Buluwayo at the beginning of the outbreak of the pest was unwise. There were numbers of transport riders willing to push on at their own risk, but they were stopped for days and weeks until their cattle sickened, hence the lack of supplies in Buluwayo was greater than need have been the case. At a spot named Palla, 245 bullock wagons were laid up when I passed, and I was told that there had been nearly double the number a month before. Abandoned and frequently looted wagons stood on the roadside, some already attacked by the white ants. We also came across small camps where the families of people intending to settle in Rhodesia as carriers were stranded. Refugees were met who gave descriptions of events which did not exactly coincide with the telegrams; the carriers, mostly Dutch, had tales of losses of bullocks and freights.

At Mangwe there is a small ditched entrenchment of circular shape, around which were arranged wagons and canvas shelters, inhabited by refugees, who either could not or did not want to go away. The men, consisting mainly of Dutch farmers and transport riders, exactly the best type of men fitted for fighting in this country, formed a garrison about fifty strong. The Commandant was Mr. Van Rooyen, a noted hunter and pioneer in these parts, Hans Lee, another hunter of note who accompanied the late Lord R. Churchill on his journey through Mashonaland, was also one of the garrison.

Just when I reached the place there was some apprehension that the natives around might rise, as the news of murders and risings in the Salisbury district had spread to these parts. Besides, Mr. Armstrong the local native commissioner, had succeeded in carrying out, assisted by one Burnham, a daringly conceived plan to kill the head priest (Isiosana), a Makalaka named Gobani, in the cave where he pretended to receive the commands of the "Umlimo"; he had also succeeded in capturing other Isiosana, including Banko, Gobani's half-brother. A rescue of these prisoners might have been attempted, and therefore the laager was every night watched by nine sentries, who, however, executed their duties with great uncertainty, and at some danger to others, notably to me whn an inebriated Dutchman put his loaded rifle to my abdomen.

The universal opinion of men I met in and around Mangwe was that Buluwayo had been in a very precarious condition. At the first alarm the place was totally unprepared to resist a serious onslaught, and arms were only distributed to the people when an actual attack appeared imminent. All was confusion for some hours, and those who were present and knew the circumstances intimately assured me that had the Matabele but had the courage to advance direct on the town all would have been over with the whites there. Some of my informants who had taken part in the fighting said that until the fight on the Umgusa the whites were usually compelled to retire, their patrols were cut off, and that, had it not been for the so-called Africander corps, patrolling could not have been successfully performed. All spoke well of the ability and dash of the Africanders when coping with the Matabele.

On June 29th an "Indaba" was held at Mangwe by the native Commissioner Armstrong and Captain Van Rooyen, several hundred natives being assembled to listen to the statement of the prisoner Banko, which was to the effect that the "Umlimo," was none other than the slain Gobani. To this was added the testimony of two other men, one of whom had, at the request of Captain Van Rooyen, visited the cave and seen the body, with the ear eaten away, a fact which struck the native as an extraordinary thing, for he reasoned that an animal would not dare to touch so august a corpse, if the man had not been an impostor.

The Makalakas and the Matabele are much mixed, but in this district the former predominate largely. Still, they speak a degraded Zulu language, and from the dark semi-circle of squatting figures there arose in response to periods in the addresses of Mr.

Armstrong and the commandant a deep-toned refrain of "Yebo, Inkosi," sometimes emphasized by words of praise, meaning "White Elephant" and "Deliverer of the Deluded."

At Mangwe I received information on the best authority that Buluwayo offered no encouragement to a traveller. Horse food was not procurable, every scrap sent there being necessary for the forces in the field, the grass had long ago been eaten away, horses and mules were dying of starvation there as on the road, and every necessary of life was scarce. In consequence of these facts, and learning that Imperial troops, detachments of the 7th Hussars and Mounted Infantry, were going into Rhodesia *viâ* Maclontsie, I abandoned my intention of proceeding to Buluwayo and made for Maclontsie, a journey offering the same characteristics on the road as those already described; if anything, the road was somewhat worse than hitherto, being much worn by the transport wagons which travel *viâ* Palla and Maclontsie from Mafeking to Buluwayo. The distance of 130 miles was done on 50 lbs. of mealies. To get across the bad drifts and steep inclines we off-loaded and carried the contents to lighten the wagon, which when the horse food was exhausted contained at most 300 lbs. By making treks as short as watering-places would allow, and giving up the greater part of the day for the horses to graze we just managed to reach Maclontsie. One horse, already terribly weakened from short rations, was abandoned at the Semokwe river, another became incapacitated for work by a severe strain, acquired at a frightfully bad drift, and the last drift, that of the Shashi river, was crossed by the friendly assistance of a transport rider.

Want of water was a source of trouble too, because we had to make halts on account of the worn-out condition of the animals at spots unusual for this purpose. Then it became my business to hunt for water, usually along the sandy bed of a river. Once I walked a couple of miles, scraping holes like a broody ostrich, until water was struck. On another occasion the animals were watered by dipping a bucket into a curious circular hole like a well in a mass of rock where water had collected, which I discovered after an hour's wandering through the bush following a depression in the ground.

Maclontsie, like other similar places in the protectorate, consists, at the present day, merely of a store and a few other minor buildings, the business *employés* and the clerks at the Post and Telegraph-office forming the only permanent white population. The settlement was formerly the headquarters of the Bechuana Border Police, which last year consisted but of 80 men to do work for which 500 men were originally considered necessary.

Sir Frederick Carrington must have been keenly disappointed to find that a fine force, owing its efficiency to his administration, should have been reduced to such a deplorable condition by its partial disbandment previous to the Transvaal raid.

Three or four troopers and an officer of the Bechuana Border Police were the sole occupants of the otherwise deserted lines, which now presented a painfully neglected appearance.

In a few days, however, the place was rendered lively by the advent of the detachments of Hussars and Mounted Infantry. These were destined to move in two columns, the first of which, under command of Colonel Paget, 7th Hussars, was to move *viâ* Tuli to Victoria. This column I was fortunate in obtaining permission to accompany by the courtesy of the Commanding Officer.

The second column was to move on Buluwayo through the Gwanda district, and, if necessary, to be supported by the first, which would turn off the Victoria road, should it be found free of hostile natives.

As it happened, each column went its way without hindrance. Colonel Paget's column, advancing past Tuli, plunged into the wilderness, where, practically, no information reached us till Victoria was reached.

The troops of each column consisted of about 200 men, Hussars and Mounted Infantry in equal proportions. The men were seasoned soldiers, suitably equipped for active service, though I am inclined to look with more favour upon the equipment of the Mounted Infantry of the West Riding Regiment as better fitted for South African work than that of the smart 7th, who were in Khaki uniforms and helmets. The Mounted Infantry wore blue jerseys and very baggy breeches, and helmets which the men referred to jocularly as their "crush 'ats," with a truthful humour, as the unpopular head-gear was generally considerably "crushed." It was often replaced by a soft felt slouch hat, which is, undoubtedly, the pleasantest and most appropriate head-gear for South Africa. But both Hussars and Infantry presented a serviceable aspect, though their appearance would, perhaps, have shocked those people whose idea of a fighting man is a trussed-up creature, gorgeous in red, brass, yellow, and other curious combinations calculated to catch the eye—pleasant enough, perhaps, when the eye is that of a pretty maid, but very much otherwise when it attracts the eye of a hidden foe, waiting for an opportunity to put a bullet into the man with the clothes of many colours.

With ample supplies of food, the horses were in wonderfully good trim, though the mule wagons, forming the train, caused considerable anxiety and trouble. After the long journey from Mafeking, the column pushed on to Tuli as soon as possible, but, owing to delay in the arrival of two Maxim guns, the force was not complete and ready to start until August 3rd, after which date, day followed day with a monotony unbroken by excitement of battle or rumour of war. The only time we heard of the enemy, was on the 7th, when some of Litoutse's people reported the presence of Matabele in the distant hills on our left flank. These, however, appear to have been more bent on seeking immunity from attack by living among the broken hills and kopjes, where mounted men can with difficulty approach them, than by acting on the offensive. It was, however, thought prudent to form laager sometimes.

Thus our march became a peaceful operation of trekking, not without the difficulties already described as being my personal experiences, as far as Maclontsie, excepting that a food supply existed in ample quantities. I had left my useless wagon and horses at Maclontsie, and proceeded with two horses and my driver, congratulating myself on no longer having to bear the anxieties experienced from lack of food, &c.

But the troubles connected with transport, always most difficult to organise and control on expeditions through wild countries, had been unnecessarily complicated by the engagement of incapable conductors and drivers at Mafeking. Before Maclontsie had been reached, incompetent "boys" and conductors were constantly being dismissed and others not much better were engaged. During the greater part of the journey there was a struggle to keep the lazy and incapable ones up to the mark, as these worthies often caused checks by driving into the worst part of the road, or running into trees. Wheels shrinking from the dry heat worked loose, and tyres were apt to fall off. "Disselbooms" or poles worked loose in their joints, and sometimes broke the bolts; while nuts loosened and fell off from continual jolting and want of careful observation. Before the column had got very far from Tuli desertions became rife, and one night nineteen "boys" disappeared together, but their places were taken next day by mounted infantrymen. Thus necessity caused an experiment to be tried which proved in time a success, and for future expeditions—when a small, compact fighting force is needed—the employment of soldiers accustomed to order and discipline, which Cape boys are not, would be of immense advantage, as in case of attacks the soldiers would take part in the defence, which boys as a rule do not, possessing as they do a strong instinct to crawl under wagons on such occasions.

The route is considered well watered, but, owing to an unusually dry season, water was not found either plentifully or in convenient spots, consequently it proved best to travel in two detachments. The marches had to be regulated by distances between watering-places. More than once water had to be dug for, causing some anxiety, and the animals were kept longer in harness than was desired by officers of detachments, who manifested every consideration for the treatment of the transport animals and material according to approved colonial methods.

Reveille sounded at times varying from 3 to 5 a.m., and after the horses are fed, kits repacked and coffee cooked, the column moves off along the narrow road, shut in by dense bush. One might be riding along the bottom of a deep ditch, the stars twinkling overhead only giving light enough to enable one to discern the indistinct form of wagon or horsemen directly in front; there is a faint rattle of chains and steel accompanying the creaking, rolling sound of wheels. Close by one hears the panting of mules and the dull patter of hoofs on the road, the cracking of a whip or the yell of a driver occasionally breaking the monotony of the rumble. Should a block be caused by a stuck wagon, the night is disturbed by sounds of a more decided character—angry murmurs and something akin to oaths rising in the air, followed by the noise of breaking branches, grating spades or blows of axes or hammers, according to the nature of the mishaps. Then rises the sun at last to put an end to this groping work, and when it begins to get hot and the animals tire, if the appointed halting place is reached all is well. Horses are led to water perhaps in pools among sand and rocks, or at holes dug in that dry and barren-looking waste the bed of a South African river in the dry season.

Perhaps the most prominent feature of travel was the crossing of numerous rivers, or, more accurately speaking, of river beds, for water or current was never an obstacle. The drifts are bad cuttings made from the bank to the level of the bed and are invariably too steep. Their ascent is hard work for the best teams. These drifts are characteristic of South African methods in such things which bear too much the stamp of originating from the genius of Dutch Voortrekkers to be of a high standard.

The impression the rivers, until we reached the Nuanetse, made upon me was that if they could be taken and put together, their area of sand and rock would form a very fine specimen of a desert.

On nearing the Nuanetse river we passed through a region covered with granite kopjes of strange castellated shapes or rising in huge weather-beaten domes from the fringe of dull coloured bush at their bases. Here the vegetation and yellow grass was denser than in the more open glade-like spots and broke the monotony of the interminable wearisome bush. These formations, rising above the apparently level sea of bush, not in ranges, but each isolated like islands or islets, are the most extraordinary features of the country.

On the Lundi river we saw a low circular building like a small fort built by the mysterious gold mining race, whose identity has not yet been satisfactorily established. Before reaching Victoria some abandoned gold mining works situated in an unhealthy-looking valley were the first indications of the precious metal which attracts ancient and moderns alike to risk their health and life in a country which does not seem to offer any very extreme advantage to the white colonists. In the rainy season, over all the district of Mashonaland, which we traversed to Victoria, a distance of 200 miles, malarial fever is rife.

Of the natives we saw little, not even footmarks on the bush paths for some days, but further on we saw grass fires and fresh tracks, and when we came to the kopjes, there were huts and patches of once cultivated land. But the natives seemed anxious to keep out of sight, though we saw some occasionally; for instance, when riding in the rear I suddenly came on a string of men and women, who had evidently been hiding until the column had passed; these people fled in alarm, and the way the ladies skipped away without dropping their burdens excited my admiration.

It was with great relief when we noticed the bush thin away half a dozen miles from Victoria. The detachment of 18 wagons and 100 Hussars could be completely seen for the first time on the march with big gaps between the wagons. The distance from front to rear must have been nearly a mile. What a defenceless crowd in the narrow road in the bush!

After so many weeks of travel enclosed by bush, it was an immense relief to allow the eye to wander over the extensive tract of open country around Victoria, which is a straggling little village crowning a rise overlooking the small stream of the Umshagashi. The houses and stores are of the ordinary description, of brick with galvanised iron roofs and verandahs, small compounds enclosing round huts with peaked thatch roofs mostly for the accommodation of native "boys," who in a rough fashion attend to those domestic duties which in Europe are undertaken by women servants.

Since the early days the place has declined. There was an exodus to Buluwayo in 1893, and ever since the first year of settlement (1891) the district has suffered from drought, war, locusts, and then again war, together with the rinderpest. The settlers, too, have suffered much from malarial fever, and a pioneer of 1891 told me that people without means have had their families decimated by this disease. Prospectors who had to expose themselves to the danger in following their calling have died alone on the veldt. Only by exercising the greatest care is it possible to avoid fever, and those whose vocation necessitates exposure find it impossible to observe the required precautions. At Victoria there is a fort, a hospital, and a Roman Catholic church. The Anglican church is a collapsed structure without a clergyman. The place lived in the midst of alarms during the Matabele rising, but was not threatened; hence the commandant, Mr. Vizard, was able to extend assistance in the shape of ammunition to Charter and Belingwe, and the necessary operations were daringly carried out by little bodies of British volunteers.

The inhabitants, who had been isolated from communication except by telegraph for many months, were delighted to find that the Tuli route was open, and that our column was to proceed to open up the road to Gwelo. The force was joined by Mr. Forrestall, one of the native commissioners, with twelve Victoria volunteers and twenty native police, who did capital work in scouting and reconnoitring. Fifty natives were also attached and speedily nicknamed the "Catch 'em alive O's" by

Tommy Atkins, presumably in sarcastic allusion to their propensity to kill and burn when there was no particular danger.

Our stay was marked by wet weather, and the loss of a few horses (one of them mine) by horse sickness.

On August 24th we started for Gwelo, marching in one column with 28 mule wagons, which as usual caused much delay and hard work. Colonel Paget pushed on as fast as possible, giving little rest to man or beast, until we entered the enemy's country, when it became necessary to exercise precautions, laager being regularly formed at halting grounds. But the rebels were satisfied that our impi was too big for them, and although repeated efforts were made to get at them, we never succeeded in doing more than destroying kraals and capturing a few little flocks of sheep and goats. Mr. Forrestall with his volunteers and natives was invariably in the van scouting by day or night. Sometimes on these night expeditions we would manage to see the enemy's fires on the hills, but when day broke the hillsides pleasantly clothed in bush looked down upon us shining innocently in the morning sunlight, and untenanted. These expeditions were very interesting, but once in my eagerness to overtake an advanced party, my pony in scrambling through an unknown ford in the dark slipped on invisible rocks, got frightened, reared and fell, depositing both of us in the water; but by holding bridle in one hand and rifle in the other, I managed to scramble out like a dog, pulling the pony after me, but leaving a spur in the water. I passed the night at a fire industriously, and with some art as I thought, drying my wet clothing until I discovered that the tail of my greatcoat was destroyed, and henceforth that garment presented a most disreputable appearance. Contrary to our experience hitherto, there was always water in the rivers between Victoria and Gwelo.

Near the Umtibekwan river we found some Maholis at home in a stronghold perched on the granite rocks of a bush-clad hill. The operations of our mounted men riding round the base of the hills tickled the native sense of humour, for some native police who had been sent up to reconnoitre, observed ten men watching our progress from their perch, where they pranced about, indulging in antics and laughter somewhat exuberantly; but later in the day it was determined to attack the stronghold, which was defended by huge rocky buttresses and precipices between which a narrow path ascended to the plateau where we could see the huts and fences of the inhabitants. The Mounted Infantry, with Mr. Forrestall and his forces, scrambled up determinedly; the defenders at first banged away, and burnt powder with their old muskets, but seeing the determination of the whites our gallant foes slipped away into hollows and caves, disappearing completely. On arriving on the plateau we found some pots still cooking, some newly brewed Kafir beer and materials for making potlegs and bullets. It was a bloodless affair, some fowls and goats were joyfully annexed, the huts were set fire to, and a few handfuls of dynamite were thrown into a huge opening where a rough ladder indicated the presence of a cave.

On another day a party of Hussars accompanied by the ubiquitous Forrestall, attempted to get at some kopje kraals one misty morning, one of which we entered after considerable difficulty, to find it a puzzling jumble of rocks, whereon stood a few huts with bins containing monkey-nuts, mealies, Kafir corn, and other grains and seeds. Gourds, hides, European loot and mining utensils were scattered about. We moved about impeded by thorn tangles, pushing pieces of hide, matting or stone over dangerous looking crevices or rocks, having first searched the way with a bullet. A big iron pot was simmering over a low fire, the contents being hoofs and lower parts of the legs of a calf, cooking with the skin on—a filthy stew in keeping with the other signs of the inhabitants' method of life. In the burrows under the rocks we could see dishes, calabashes of water, and no end of native paraphernalia of skins and twisted grass. One of the loopholes was made through the flat roof of an artfully constructed hollow below, so that the lurking savage could hold his piece up to the ceiling and discharge it as one passed over the aperture, which a "friendly" promptly popped a flat stone over. It was impossible under the circumstances to penetrate these burrows, having already spent many hours in finding ways in and about them. This day I saw two men and a horse mortally wounded from ambushes in the rocks. The projectiles used by these cave men are disgusting articles, made out of solder collected from tins, hammered into the approximate shape of a bullet. When one considers that the Mashonas' dodge is to get into a cave and fire a blunderbuss through a crevice at a few yards range, and then crawl away through a burrow below, there is little pleasurable excitement in cave fighting.

Gwelo is a "town," to use a conventional term, of the same description as Victoria, but still smaller. A strong laager formed a central mass, only a few stores of iron or brick being scattered about this enclosure. Like Buluwayo, the place was in a state of unreadiness when the rising took place. The settlers mostly found occupation in the gold mines, the wrecked and ransacked buildings of which we had seen in the Selukwe hills on our way from Victoria. Some people say that Gwelo is a healthy place, stating that few had died from fever contracted there. During the blockade, however, night pickets were abolished as too many men sickened. In the surrounding district black soil and rank grass betray swampy symptoms, and although with few exceptions, the men of our column remained in good health, local men informed me that during the rainy season these places breed fever. As elsewhere the cattle all died of the rinderpest, polluting for a long time air and water in the vicinity of the townships.

The heroic rebels, as around Buluwayo, refrained from risking their precious skins by promptly attacking the place, where for some time there were only a few hundred rounds of ammunition of all kinds for an equally insufficient number of rifles, for the English with strange fatuity seemed to overlook the obvious expediency of possessing firearms in a newly conquered country; hence, scattered and unsuspicious of danger, and even recklessly disregarding warnings, many whites fell easy victims to their murderers, who displayed the temper of their fighting metal by striking unawares under guise of transacting business.

Of these murders after leaving Gwelo, I saw horrid evidences in the desiccated corpses or bones of white men, lying on the veldt near the decaying folds of tent canvas or near the lines of burnt clay and charred wood indicating the site of a daub and wattle building; we found also the dried carcasses of dead donkeys and remains of cattle, slain by the little Englanders' dear friends—the Matabele and Maholi, who in their honest thirst for blood slew everything, even to the fowls, which incurred the wrath of the righteous savage. Gwelo being after a couple of days' stay, destitute of grain, Colonel Paget again put his column into movement to raid the country lying between the Kwekwe, Umgenya, and Gwelo rivers, for the double purpose of collecting grain, and dispersing any bodies of the enemy that might be met with; during a fortnight's marching and countermarching, the result was that our wagons which departed full came back empty of grain, many of the horses worn out for want of food, and some, with mules, left dead on the way; but we proved conclusively that the enemy without having received more than one really crushing defeat, viz., the Umgusa fight—were succumbing to the long pressure of war against which few Kafir tribes have been able to bear up successfully when contending with the whites. There was, however, the prospect that active hostilities would have to be carried on into the rainy season, when we heard of the admirably wise intervention of Mr. Cecil Rhodes, which brought the Matabeles to surrender. I heard some violent diatribes among some Rhodesians condemning everything but a prosecution of the war to the bitter end; a very bitter end for the whites, when a collapse from famine would have put an end to hostilities, a contingency which Mr. Rhodes doubtless foresaw and sought to avoid.

Every day but one I accompanied one of our raiding parties, which proved very monotonous owing to the stealthy celerity of the natives, whose eagerness to escape observation made it necessary to operate in smaller bodies than was actually the case, for there was a tendency throughout to keep close formations and to limit the area of operations. A start was made in the early morning, and for hours the party, often led by a prisoner, who was closely watched by a native auxiliary, followed the narrow paths through bush or veldt in file, until we suddenly sighted kraals or shelters; at some there was no sign of habitation, at others fires were found still burning with fresh tracks leading to hill and bush. If we were very lucky some grain would be found in large earthern pots sunk under the earthern floor of the huts, or in calabashes and skins; once we found a tin full of grain, which, however, did not go far amongst 200 horses and twice as many mules; women and children were occasionally caught, and sometimes a man, if he escaped being shot by the volunteers, who used to dash out ahead of the main body. The kraals were mostly set fire to after a cursory examination, a foolish proceeding for it betrayed our whereabouts to numerous parties of the enemy on the hills or elsewhere around. The prisoners proved very useless lumber. They had to be fed, and as they were only subjected to a mild system of questioning, the ladies kept their knowledge to themselves. At first, they were objects of intense interest to our men, who crowded round, laughing and craning their heads to get a squint at "these ere Mattabeely."

The country in these parts was mostly bush, but fairly open and flat, with low ridges of stoney, bush-covered hills. Grass fires were frequent, and for the safety of the laager, the site used to be burnt. The natives were in some places ploughing; this was in September. The general characteristics were always very much the same, cool nights, hot days with hot winds, much dust, burnt grass, flies, and sometimes a lack of water when raiding. As a rule the enemy remained concealed, but we destroyed his huts, shot his stragglers, drank his water, and made him generally uncomfortable.

On one occasion, I noticed a tree of fair growth among some kraals. It is named m'tchagata in Mashona, and umkuna in Matabele. It was rendered conspicuous by a slight fence, whence were suspended strips of bark. This fence I was informed by Mashona friendlies marks the tree as an "umtoro," the dwelling place of the local spirit, supposed to control the destiny of the people. When drought threatens the natives drink beer and dance to the deity. When going hunting, the men strip part of the bark off a stick, twist it round the top, and lean the stick against the tree trunk. Sometimes they will dance round the tree, stabbing at it with assegais, these performances being considered likely to ensure good fortune in the chase. Instead of a fence the "umtoro" is also distinguished by a three sided hut in front, wherein beer is deposited before the dance, to be withdrawn and consumed by the thirsty devotees at the conclusion of that ceremony. These, with several other ceremonies and superstitions connected with the "umtoro," belong to the Mashona, not to the Matabele, though from the presence of the tree at the spot seen it seems that the Maholi at least are influenced by and practice these observances.

Hardly had we reached Gwelo again, before it came to my knowledge that a Mr. C. was about to start with a donkey-cart for Buluwayo, and I was fortunate in being able to arrange to travel with him. The war was practically over, thanks to Mr. Rhodes, but the roads were not yet open, and there was still fighting going on, excepting in the Matoppos. Therefore the opportunity to turn my back upon Gwelo came quite *à propos*, and I availed myself of it promptly, for humble as the conveyance may seem, a donkey-cart is not to be despised in Rhodesia. Our party consisted of five white men, one St. Helena man (my servant) and two Kafirs, who assisted in looking after the donkeys and cart, which conveyed our baggage and food. Two were mounted and armed with rifles. Mr. C. had an ancient fowling piece. I had my revolver and my pony, which I did not ride so long as I was with the cart, for the poor brute was getting low for want of food, and the ticks in these districts settled upon the animals in astounding numbers.

Soon after leaving Gwelo the landscape was open, vast and undulating. There was scarcely a bush to be seen, but stones and small ant-heaps abound. Great spaces had been burnt over by grass fires, and the scene was dreary in the extreme. Locusts in myriads settled on the ground or hung like dead red leaves on every stalk of grass or scrub. Benumbed by the chill of night these insects remained in a helpless condition, allowing themselves to be trodden under foot, but shortly after the rising sun had sent its almost horizontal rays across the plains a strong wind arose and bore the locusts along in clouds. On they came like a coppery red snowstorm, settling on the ground in such multitudes as to darken it, and springing up again after a short rest to resume their flight. Three days before reaching Gwelo locusts had appeared, but not in such swarms as we encountered for three days after leaving Gwelo. They always move in the same direction.

Following the general custom of South African travel we rose in the small hours and travelled until the sun was well up, when a halt would be made until the declining sun made the donkey's work easier. Blankets would be arranged round the cart or a bush, if one happened to be at hand, and generally towards noon quivering waves of the heated air were driven along the surface of the ground by a strong hot wind. Thus the sensation caused by the state of the atmosphere was more than summerlike, and I lazily watched strange little prickly lizards dodging about the inequalities of the sun-parched soil. The feet of my companions projected motionless from under the shade of the blankets, whence came the homely sounds of snores; the footgear was not always in a perfect condition, whether boots or socks were exposed to gaze, indeed none of us exhibited an ideal appearance, for jackets, breeches and shirts had all suffered from aggressive thorns, while hard wear, dust, perspiration, with grease spots gathered by working and eating under awkward circumstances, made us look like vagabonds according to civilised standards. A Cicada would sometimes start a cheerful rattle, but usually collapsed before long on account of the heat, and swarms of flies, common vulgar flies, foolishly buzzed round one's nose, and even walked upon that august organ. So monotonously the day wore on; the heat was evaded as much as possible by following the shadows round the cart or bush. At last the sun began to decline, the sleepers awoke, a meal was prepared, and as soon as the heat diminished our little procession again moved forward for another four hours or so.

On the morning of September 27th we sighted the pretty open slopes, pleasantly alternating with belts of bush, of the granite-topped hills overlooking the Shangani. Here was a small circular entrenchment, garrisoned by ten white men and eight or nine Cape boys, under the charge of a police officer, who was evidently troubled by the imbecile conduct of his white men, who were all more or less drunk. I may here remark that the commandant at Gwelo was also struggling with the drunkenness prevailing in the place. At Victoria, too, drink was commoner than food, and I heard people complaining that liquor should be sent in such quantities when the real necessaries of life were needed. The transport wagons I saw in Bechuanaland carried an enormous proportion of liquor compared to food stuffs.

I forgot to mention that an important member of our party was "Bill Sykes," a dog belonging to Mr. C., and of no particular breed or shape, but possessing much bristling hair and ferocity. One night, about midnight, the furious barking of Bill Sykes caused us to roll out of our blankets and look round with hair on end. On the opposite side of the track we beheld a mysterious draped figure looming up in the misty light of a moon concealed by flying clouds. Hands instinctively sought weapons, but a voice in broken English from the startling apparition informed us it was only "me," one of our companions, L., an Africander. It seemed that we had only just recovered from this alarm, when I suddenly awoke again without warning, and discerned some objects moving towards us about a hundred yards off. Bill Sykes barked fiercely. "Look out you fellows," I sang out, and all turned in their blankets again. "Who come dare?" shouted L., grasping his rifle. "Friends," came the reassuring reply, and the objects approaching closer we were able to discern horsemen, and then we heard wagons creaking quietly behind them; it was a convoy *en route* to Gwelo.

The night after leaving the Shangani was rather an anxious one. Our mounted and armed companions remained at the fort to enjoy the liquor, the effect of which had already reduced another of the party to a state which induced him to keep lying down at the roadside. We outspanned on an open spot whence we could see the fire of some natives on a ridge. The "boys" on being sent for water would not venture to fetch it. A lion had been seen close to the place the day before, and Mr. C. further expressed anxiety about hyenas which had previously attacked his donkeys on a dark night. Whilst Mr. C. and I sat up smoking and watching until the moon should rise, he remarked, "This comes of putting faith in drunkards." But generally, for want of a ltttle organisation by which we might have sat up in turn, our nights were restless. Once again we saw a native fire close to the road, when Mr. C. displayed an extraordinary infatuation for the display of a lantern as if he was walking down an English lane instead of trekking across a wilderness in South Africa, with natives in rebellion scattered about. The morning following this incident the boy sent for water shouted an alarm, and running to his assistance I caught sight of a native bobbing along behind a ridge where he subsequently disappeared. When I reached the boy he told me that two natives came towards him or the water, so he gave the alarm.

About forty miles from Buluwayo it was thought safe to leave Mr. C. and the cart to come on without escort, and the rifles being left for him and his remaining companion, we three, who possessed horses, pushed ahead. But our progress was poor, the animals being weak for want of hard food; my companions did not prove good travellers, being careless and with a power of sleep quite phenomenal. For two nights heavy thunder storms swept over us, once as we lay in the bush, but though a violent wind raised clouds of blinding dust which pelted us unmercifully, little rain fell.

At last, on the morning of October 1st, we rode into Buluwayo from the surrounding bush, and rejoiced that our tedious journey was ended. All the way from Gwelo we saw but few signs of life—no cattle, no kraals, no cultivated lands, hardly a head of game, only at miles apart, the little heaps of dirt and charred ruins of a burnt daub and wattle-built store, surrounded by broken bottles, tins, and such like evidences of civilisation.

The first impression upon nearing Buluwayo was the extensive area of the buildings and the proximity of the bush, which two facts at once made one comprehend the difficulty of defending the town with a handful of men against thousands of savages; it would be better to clear away the bush, and plant better trees systematically. I was told, however, that an obstacle to such a plan was the difficulty of rearing young trees, such as the very useful Australian gums, on account of the attacks of white ants, which are a great pest in other ways. Of course, the place is so young that many things are necessarily neglected, and it has every characteristic of a town in its early stages stamped upon it. Nevertheless, there are signs of energy and capital far above the ordinary; the main street has already many blocks of "chambers" to be utilised as offices, but, like most buildings in South African towns, there is not sufficient regard for the conditions of climate; walls are thin, and roofs of iron are not sufficiently substantial to keep rooms cool and comfortable, and the pattern is too English. Water was scarce, and the inhabitants relied upon wells; there is a large public well in the market-place, but, when I alluded to the waterworks residents laughed and said there was no water in the reservoirs, nor likely to be, and that for two seasons the rainfall had not been anything like as heavy as was anticipated.

In the market-place there still stood some wagons of the laager where 680 women were at one time cooped up in the market building. One who was there testified to the awful state of the atmosphere, when infants died nightly for want of milk and proper food

Meat was bad and scarce. Overdriven trekk bullocks which had managed to reach the town without dying of rinderpest provided the beef, and the mutton was mostly raised under goatskins. A tiny loaf of bread cost 1s., a cauliflower, from 3s. to 15s., a cabbage, from 3s. to 7s. 6d., eggs, 25s. per dozen, but even in ordinary times eggs are excessively dear, as fowls succumb in Buluwayo to some unknown disease. Mealies fetched £8 and £10 per bag of 200 lbs., millet, which my starving pony would refuse to eat much of, cost 1s. 6d. per lb.

Though I did not witness any remarkable amount of drunkenness, still there was much drinking, even by men of a class who in England find better forms of relaxation and entertainment. I have seen men staggering about at 8 o'clock in the morning, and it filled me with shame to see the drunken European fool making himself a familiar object o ridicule to low men of colour and natives. It does not seem to be recognised how much th prestige of the white man suffers by th frequency and immunity of such exhibitions. If it were only realised how much the contro over native races depends upon the respec and awe with which the latter look up to th white man as a superior, the public exhibitio of drunkenness would be sternly discoun-tenanced by the authorities, who would doubt less receive the support of the bulk of th population.

Whatever failings exist in the administra tion of the Company, I never heard any com plaint of such a serious nature as to call for a withdrawal of the Charter. The mistake made by inexperienced and incapable official have been of the same nature as those whic our own irreproachable Home Governmen have made—in South Africa too. I did no find the white inhabitants of Rhodesia i favour of the substitution of Imperial Govern ment, in spite of the difficulties and hardship with which they have been confronted, in con sequence of the errors committed by the Com pany.

Above all things, I think the railroad polic of the British South African Company calls fo most criticism, and with the examples befor them of the development of new territories on th American continent, as exemplified by th splendid system of the Canadian Pacific Rai way, it is difficult for those who are respons ble for the Company's policy to account sati factorily for the strange neglect of so great civilising agency, and how with the example the Tabi concession before them it was suppose that gold mining could be profitably engage in hundreds of miles away in the interior.

Of course, I saw the territories at the worst, suffering from war and the want necessaries of life in consequence of rinde pest. Therefore I ought not to venture on decided opinion, but my impressions were th there is good cattle country and good agricu tural country, but the working of the latter handicapped by the regular fever season whic sets in, and the experience of other parts South Africa does not convince me that catt are a source of wealth to South Africa. conclude, therefore, that everything depen upon the profitable development of the go ining industry, a fact not yet completely oved to general satisfaction in South Africa far as my inquiries could determine.

I will not inflict upon you any of my exeriences on my return journey to Cape Town, hich was made by coach to Mochudi, in the rotectorate, and thence by railway. It will ffice to say that the coach service is of such inferior description as would only be tolerted in South Africa, where travelling bears o strongly the impress of the Dutch Hottentot ethods and example.

DISCUSSION.

Mr. FRIPP, in answer to an inquiry respecting e prospects of gold-mining in Rhodesia, said he ould give very little information on the subject, ecause, owing to the war and the rinderpest, all e works had been closed and deserted. On one ccasion he had an opportunity of going into an ncient working, and an expert told him that the ncients seemed to have understood their work unommonly well, and that they had worked out the eef to the utmost so far as they had gone. The hole industry was now at a standstill, and there as nothing to go by except what people said, and e must say that the evidence of this kind was very ontradictory, and seemed to be very much coloured y the interests of the speakers.

The CHAIRMAN, in proposing a vote of thanks to r. Fripp, said the paper had been very interesting, nd the photographs had given a very good idea of he country, in fact he had been able to realize what he real nature of the country was, much better than e had ever done before. The sketches on the wall lso showed Mr. Fripp's ability with the pen and encil, and he only hoped that he would continue his ourneyings, and give them a further paper on some uture occasion. This country was evidently as yet uite undeveloped, and no doubt in course of a few ears it would present a very different appearance. s had been remarked, Mr. Cecil Rhodes had a very arge interest in the country, and no doubt the result f his exertions would soon show itself. For instance, e was going to introduce railways, which was a atter of primary importance in a country where ravelling was so difficult, in consequence of the inderpest. With regard to gold-mining, about which Mr. Fripp was not able to say much, it must be remembered that he had been in a part of the country where it had only just been started; if he had been in the Transvaal no doubt he would have been able to give a more flourishing account of the prospects of the industry. He had no doubt that as civilisation advanced the population and wealth of the country would increase.

CONTRIBUTIONS TOWARDS THE BIBLIOGRAPHY OF PHOTOGRAPHY IN COLOURS.

By THOMAS BOLAS, F.C.S., F.I.C.

In view of the recent interest taken in heliochromy, the following may possibly be of value to the experimenter as showing him where to find record of the work of others.

It must not be regarded as even approximating to completeness, but it may serve as a beginning to which others may add, and thus become the basis of a tolerably exhaustive index to what has been published.

1810. T. J. SEEBECK.

Referred to in Goethe's "Farbenlehre" and in Hunt's "Manual of Photography" as having noticed the local colourisation of chloride of silver under the spectral rays; brown to violet and blue in the violet rays, blue in the blue rays, and red in the red rays.

1829. I. NICÉPHORE NIÉPCE.

> Documents deposited with Daguerre in relation to his partnership, and published in 1839 by order of French Government. Following from letter by Niépce, dated December 5, 1829. The English translation is from the "History and Practice of Photogenic Drawing" (I. S. Memes. London, 1839), this book being a translation of the official publication regarding Daguerreotype and collateral matters, by the French Government.

Niépce details the results of exposing a glass plate coated with bitumen in the camera and says: "If this landscape be viewed by reflection in a mirror, on the varnished side, and at a certain angle, the effect is striking, while, seen by transmission, it presents only confused and shapeless imagery; but what is really surprising, in this position the mimic tracery seems to assume the local colours of certain objects." Niépce theorises on the subject, and compares the colours to those of Newton's rings.

1839. SIR JOHN HERSCHEL.

In this year commenced the series of papers read before the Royal Society by Sir John Herschel on photographic processes. The most important appeared in the "Philosophical Transactions," 1840. In this he describes the character of the coloured spectral image obtained on paper sensitised with silver chloride (Talbot's process) and refers to the "possible future production of naturally coloured photographic images." It was followed by another in 1842 and later by others. Sir John Herschel also published the results of some of his researches as communications to the British Association, but unfortunately the Association reports are very meagre. One of these (1841) accompanies a collection of "coloured photographic copies of engravings and mezzotints, into the preparation of which no metallic ingredients enter, the whole being tinted with substances of vegetable origin." The method, says the author, "holds out no slight hope of a solution of the problem of a photographic representation of natural objects in their proper colours." In another (1839) he refers to his observation (apparently announced about June or July, 1839) that coloured images of the spectrum could be obtained on sensitised paper.

1844. ROBERT HUNT.

Hunt devotes a chapter in his "Researches on Light" to "the probability of producing coloured pictures by the solar radiations," and describes the production of coloured images on chloride of silver paper. He also (p. 105) states that he had obtained a coloured image of the spectrum on paper prepared with nitrate of silver and fluoride of soda. He mentions that Sir John Herschel was the first to obtain "any good specimens of photographically impressed prismatic colourations." This book contains the results of researches previously published in various papers to the Royal Society, the British Association, &c., 1840 to 1844.

1848. ED. BECQUEREL.

Comptes Rendus de l'Académie des Sciences, Paris, 22 (1848) 181, 27, 485.

Discusses the colours produced by spectral rays on chloride of silver, and describes various methods of obtaining spectral impressions on chlorinised silver plates. The subject is further treated of in his text-book on light, published in 1867.

1851. NIÉPCE DE ST. VICTOR.

From 1851 to his death in 1870, published many details as to the obtaining of coloured images on silver chloride, but like those obtained by Becquerel they were unfixed. His last paper is to be found in the *Comptes Rendus* for 1866.

1855. TESTUD DE BEAUREGARD.

I gather the following, not from the original sources, but from Herr Hermann Krone's book, "Die Darstellung der Natürlichen Farben durch Photographie," Weimar, 1894.

At a meeting of the Société Française de Photographie held in 1855 (*see* Bul. Soc. Fran. Photo., 1855, p. 153; Phot. Soc. Journ. II., 1856, pp. 195-197), Beauregard exhibited prints showing the colours of the original objects, which photographs had been obtained by exposing a sensitive surface to white light under what appeared to be a monochrome negative (collodion) in which it was claimed the colours were latent. The latent colours, whether in fixed negative or print, could be called forth by using special preparations or solutions. The following are mentioned: a silver solution, chromic acid oxide of chromium (presumably a salt), sulphate of iron, gallic acid. Baths used in the first preparation of the paper were permanganate of potassium to which litmus had been added, and ferricyanide of potassium to which sulphuric acid had been added. Next the paper was sensitised with a silver solution, exposed fixed with hyposulphite, and a bath of ammonium gallate was then used.

In some cases the colours on the print appear to have been produced in the printing frame, the subsequent treatment having served to increase their vigour, but the particulars given are obviously too incomplete to serve as an exact guide to other workers; Zenker for example having failed to produce coloured effects. M. Durien, who occupied the chair, distinctly certified that he had seen the colours produced by printing under the collodion negative. MM. Durien, Becquerel, Regnault, Silbermann, and others, concluded that the negative could not be a true monochrome, and Silbermann believed he could recognise it as coloured. In a later communication to the French Photographic Society (17 April, 1857), M. Beauregard said that when a glass plate coated with a chlorinised collodion receives a short exposure to a coloured image such as is given in taking an ordinary negative, very often a negative is produced in which the colours are latent, but capable of development by suitable toning agencies. He further says that if such an image is fixed in cyanide, dried in the dark, and exposed to slightly chlorinated iodine fumes, the colours gradually appear and gain in intensity, but the exposure to the vapour must be broken off now and again to expose the picture to sunlight. An acid solution of gold chloride may be used at this stage.

Beauregard failed to completely reproduce he spectrum, and considers that white light s an essential in his method of working.

1858. THOMPSON (of Ross and Thompson, Edinburgh).

Sutton in his *Dictionary of Photography*, 1858, p. 299, says:—"We must refer the reader to a pamphlet published by Mr. Thompson (of Messrs. Ross and Thompson, Edinburgh), for particulars of various experiments which have been made by different persons with a view to the discovery of photography in natural colours."

1859. ALCIDE DUCOS DU HAURON.

In "La Triplice Photographique des Couleurs et l'imprimerie, Système de Photochromographie," Paris, 1897, Alcide Ducos du Hauron gives a very full summary of the method of his brother Louis Ducos du Hauron, and a list of his various publications regarding Heliochromy and other subjects. The first item in this list is:—

"20 Janvier, 1859. Communication à la Société des Sciences et Arts d'Agen d'une Memoire fort étendu ayant pour titre; étude sur les sensations lumineuse."

The second item is:—

"14 Juillet, 1862. Communication à M. Lélut, Membre de l'Institut d'une Méthode de reconstitution photographique des couleurs par triple tamisage des rayons et par triple réversion d'empreintes."

1865. H. COLLEN.

British Journal of Photography, 1865, p. 547.

An early suggestion as to three colour heliochromy, Collen stated the problem as the making of three negatives by the blue, red, and yellow rays respectively, taking a film print from each of these in the colour which produced the negative, and superimposing the film prints.

1866. ALPHONSE LOUIS POITEVIN.

Communications to French Photographic Society, January 12, 1866, and 7 December, 1866.

Observation on the direct rendering of colour on silver chloride or sub-chloride.

1866. G. WHARTON SIMPSON.

Photographic News, 1866, p. 73.

Collodio-chloride of silver was prepared with the slightest possible excess of silver nitrate, and a plate of opal glass coated with this was dried before a fire and exposed to daylight until it had become lavender-grey or slate colour. This was exposed for some hours to sunlight. Where the film was uncovered the film became bronzed black, where covered with colourless or yellowish glass it became yellowish-white, where covered by ruby glass claret or magenta coloured; under orange glass the film took a somewhat redder tint than that of the orange glass, under white glass covered with aniline red the tint ranged from orange to deep purple red, and under glass coated with aniline green, the film became deep green.

1867. CHARLES CROS.

In a French patent, 2nd December, 1867, set forth a theory of three-colour heliochromy independently of Ducos du Hauron, but he suggested taking the three negatives by red, yellow, and blue light. The elements of the chromogramme were to be united by means of a kind of zoetrope.

1867. NIÉPCE DE ST. VICTOR.

Showed in the Paris Exhibition of that year some colour photographs. Vogel's "Chemistry of Light," &c., says they were shown in half-closed boxes, in subdued daylight, and lasted about a week.

1868. LOUIS DUCOS DU HAURON.

French Patent, 83061, of Nov. 23, 1868.

The specification describes the three-colour method with three negatives, also with a single plate exposed behind a screen ruled or plotted out in three colours.

1868. Dr. WILHELM ZENKER.

Lehrbuch der Photochromie. Berlin, 1868. Published by the author.

Is said to contain the theoretical aspect of what is known as the Lippmann process. I have not seen the book, but frequent reference is made to it in Wiener's Memoir on Heliochromy, Lippmann's original paper, and other publications.

1869. LOUIS DUCOS DU HAURON.

Les Couleurs en Photographie. Solution du Problem. Paris, 1869. A. Marion.

This contains an account of the three-colour process in its various forms, the fundamental position being to take the negatives under screens corresponding to the Young-Helmholtz colour sensations, and to make a print with transparent colouring materials having complementary tints. A method with a screen ruled in three colours, and similar to that now known as the Joly method is described.

1873. G. W. SIMPSON.

The Influence of Coloured Light on the Tone of Prints. *Photographic News*, 1873, p. 246.

1876. LOUIS DUCOS DU HAURON.

English Patent, No. 2973, of 1876.

Describes the three-colour method, also special camera with reflectors for taking the three images and similar device for viewing.

1876. Dr. HERMANN VOGEL.

Devotes a chapter of his "Chemistry of Light and Photography" (International Scientific Series) to the subject of Photography in natural colours. It is a short historical sketch of the subject.

1878. A. & L. DUCOS DU HAURON (Frères).

Traité de Photographie des Couleurs. Système d' Héliochromie. Louis Ducos du Hauron. 108 pages. Paris, 1878. Gauthier-Villars.

The work includes colour-corrected sensitive plates, but, in other respects, is not very different from Louis Ducos du Hauron's book of 1869.

1879. CAPTAIN W. DE W. ABNEY.

Proceedings of the Royal Society, xxix., 190; xxxiii., 164.

A study of the production of colours on silver chloride, especially on a chlorinised Daguerrotype plate. Abney finds that peroxide of hydrogen, before or after exposure, brings about a more rapid production of colour, and he shadows forth (1879) Wiener's recent theory as to the several forms of silver haloid which may be specially absorbent of various spectral rays.

1879. J. M. EDER.

Über die Chemische Wirkungen des Farbigen Lichtes und die Photographie in Naturlichen Farben. 68 pages. Wien, 1879. Verlag der Photographischen Correspondenz (Dr. E. Hornig).

1881. CHARLES CROS.

Moniteur de la Photographie, 1881, page 64. "Hydrotypie et Polychromie Immediate."

The coloured image—that of the camera, for instance—is received on a chromo-sensitive surface composed of red, yellow and blue superimposed or juxtaposed, the colouring materials being so selected that each is destroyed by complementary radiations. Thus, the orange rays destroy the blue pigment, the green rays destroy the red pigment, and the violet rays destroy the yellow pigment. On glass we have first collodion coloured red by cartharnine, then gelatine coloured blue by phyllocyanine, and finally collodion made yellow by curcuma.

1883 CAPTAIN W. DE W. ABNEY.

English Edition of Eder's "Chemical Effect of the Spectrum." London, 1883. Harrison.

Abney's footnotes often throw a new light on matters bearing on heliochromy.

1884. E. LIESEGANG.

Die Heliochromie; das Problem des Photographirens in den näturlichen Farben, Düsseldorf, 1884. Liesegang's Verlag.

A summary of early work, more especially that of Niépce de St. Victor, Becquerel, and Poitevin.

1886. F. E. IVES.

Iso-chromatic Photography with Chlorophyl. Philadelphia, 1886. Printed by the author.

This work contains much miscellaneous information showing how the author was led to a study of theoretical and practical heliochromy.

A New Principle in Heliochromy. Philadelphia, 1889. Published by the author.

Deals with the fundamental principles of heliochromy.

Hand-book of the Photochromoscope. London, 1894. Simpkin, Marshall, Hamilton, Kent and Co.

Papers read before the Society of Arts and the Camera Club on his Photochromoscope. *Journal of the Society of Arts*, vol. xl. (1892), p. 687; vol. xli. (1893), p. 663. *Camera Club Journal*, Feb. 1897, p. 23.

1887. M. CAREY LEA.

On red and purple Chloride, Bromide, and Iodide of Silver; on Heliochromy, and on the Latent Photographic image. "American Journal of Sciences," May, 1887 (Third Series, Vol. xxxiii., p. 34). *Photographic News*, 1887, p. 326.

Describes the production by chemical means of coloured haloid salts of silver, which he terms photo-salts. As bearing on Wiener's theory of body-colour heliochromy with one surface, the following extracts may be made :—

"Exposed to ordinary diffused light air the bright shades of silver photo-chloride quickly change to purple and purple-black. The darker shades are more slowly influenced."

Relations of Photo-chloride to Heliochromy.

"The photo-chloride was examined both with the spectrum and under coloured glass. The rose-coloured form of photo-chloride was that which gave the best effect. In the violet of the spectrum it assumed a pure violet colour, in the blue it acquired a state of blue, in green and yellow a bleaching influence was shown, in the red it remained unchanged. The maximum effect was about the line F, with another maximum at the end of the visible violet, less marked than the one at F.

"Under coloured glass the colours obtained were brighter; under two thicknesses of dark ruby glass the colour became brighter and richer. Under blue glass some specimens gave a fair blue, others merely grey. Under cobalt a deep blue was easily obtained, and under manganese violet a fine violet, very distinct in shade from cobalt. Green produced but little effect; yellow was sometimes faintly reproduced but rarely. But the yellow glass of commerce lets through portions of nearly the whole spectrum, as can readily be seen by testing it with the spectroscope."

"Hardly two specimens of photo-chloride give exactly the same results with coloured lights, and this suggests great possibilities."

"Evidently an important point in all heliochromic processes is that white light must be represented by white in the image, it is an essential condition that white light must exert a bleaching action on the sensitive substance employed. Red chloride of silver does not bleach, but darkens in white light; but the property of bleaching, to a very considerable extent, may be conferred on it by certain other chlorides, and particularly by lead chloride and zinc chloride."

"I am persuaded that in the reaction which have been here described lies the future of heliochromy, and that in some form or other the beautiful red chloride is destined to lead eventually to the reproduction of natural colours."

1888. GERMEUIL-BONNAUD.

Patent specification, No. 1751, February 6, 1888, quoted in *Photographic News*, 1889, p. 458.

A sensitive mixture is prepared, *e.g.*, with 100 c.c. water, 20 grammes treacle, 10 grammes borate of soda, and 5 to 20 grammes of bichromate of potash. A surface (*e.g.* glass) coated with this is dried, exposed under a positive and dusted with various coloured pigments, that representing the general shade being first used. The colours are stated to adhere discriminatively reproducing the original scene, although as far as can be gathered a monochrome positive is used. Details as to transfer and vitrifying of pictures are of no special interest.

1889. C. V. BOYS.

Photographic News, 1889, page 458. Report on a dusting process of Germeuil-Bonnaud.

The dusting process of Germeuil-Bonnaud appears to possess no very fundamental difference from other "dusting-on methods," using the term in the ordinary sense, but this inventor claims that dusting-on colours adhere so as to reproduce the tints of the original with more or less fidelity. Mr. Boys, in his report, says :—

"The colours do not appear to adhere indiscriminately, but to fall into their proper places as if directed by an unseen hand. For instance, in a landscape that I saw copied by this process the blue powder was first dusted on and then a suitable shade of green. On examination it was found that the sky was blue and the leaves of the nearer trees green, while the more distant trees were of a slightly different shade, giving the effect of distance perfectly."

It appeared, however, doubtful whether this was due to a selective action, or to the various "tackiness" of different parts of the film.

1889. OTTO WIENER.

Wiedemann's Annalen, 1st vol. of 1890 (New Series XL.), p. 203. Stehende Lichtwellen und die Schwingungs-Richtung Polarisirten Lichtes (a paper read at the 1889 meeting of Deutscher Naturforscher und Aertze, reported on p. 209 of the official proceedings (*Tageblatt der Versammlung*).

The author desired to demonstrate the existence of standing or stationary waves when interference occurs, by some means comparable to that adopted by Hertz in the case of Hertzian light; and after a review of the various reactions of light available for the purpose of obtaining a record, he concluded that photo-chemical action would be most suitable.

Obviously the ordinary gelatine plate would be out of the question, as, apart from its opacity, the thickness of the film would be enormous in relation to the work in hand; indeed, this thickness would have to be expressed in hundredths of a millimetre, and several hundred wave fronts could be ranged as a series in the thickness of the film. It was therefore necessary to seek for some photographic film which should not only be transparent, but the thickness of which should be fairly small in comparison with a wave length. The author then found that Zenker had, in or before 1868, attempted to obtain records of standing or stationary waves on a thin photographic film as a means of solving the problem of photography in natural colours.

The author, by the following means, obtained a transparent film having a thickness of from one-twentieth to one-fortieth the wave length of sodium light.

Collodio-chloride of silver as sold in two preparations by Schippang and Company, of Berlin. The two constituents of this preparation (the general nature of which is well-known to photographic practitioners) were diluted with from 15 to 20 volumes of alcohol and mixed. To obtain a film of the required tenuity on a glass plate, a few drops were poured on a flat glass, another glass was brought down on the fluid quickly so as to spread the fluid, after which the glasses were separated and dried in a horizontal position. The coated plate can hardly be distinguished from an uncoated plate ; indeed, the liquid preparation used appeared clear like water, and must be looked on rather as a solution than as an emulsion. In one case, three drops of a nineteen times diluted preparation covered 35 square centimetres of glass, and experiment showed the thickness of the film to be only one-thirtieth of the wave length of sodium light ; the means adopted being to scrape away a little of the film, lay on another glass, and deduce the thickness from the interference phenomena of the air space. This experiment was checked by a calculation based on the known solid contents of the sensitive solution or emulsion. Thinly silvered glass plates subsequently exposed to the fumes of iodine, were also used.

The transparent sensitive film on glass being now placed in contact with or at slight inclination to a silver on glass reflector, interference effects were recorded on the film in accordance with the theory of standing or stationary waves, spectral or other light being used.

1889. RAPHAEL MELDOLA.

In his "Chemistry of Photography," gives a short general sketch of the subject of photochromy, and describes a method by G. Staats (quoted from the Ber. Deutsch. Chem. Gesell., 1887, p. 2322) of producing coloured images on silver chloride.

1890. E. DE SAINT FLORENT.

Bulletin de la Société Française de Photographie, 1890, p. 229.

Paper is coated with collodion containing nitrate of silver, and the dry film is treated with hydrochloric acid, after which sufficient exposure to light is given to give a deep bluish tinge. If now saturated with a solution of nitrate of mercury it will take the colours of a superimposed transparency by an exposure of a few minutes. A solution of one part of ferric chloride in about thirty of water partially fixes the coloured image.

1890. F. VERESS.

Photographic News, 1890, p. 276.

An account is given of reproductions in colour. Collodio-chloride of silver is treated in some special way (not stated) and upon it are obtained prints showing extremely brilliant colours, but apparently not altogether true to the original, green being absent.

1891. ALPHONSE BERGET.

Photographie des Couleurs, par la methode interferentielle de M. Lippmann, 58 pages, Paris, 1891, Gauthier Villars et Fils.

A concise historical, theoretical, and practical account of interference heliochromy.

1891. G. LIPPMANN.

Comptes Rendus, cxii., p. 274. (1891.)

The now celebrated method of exposing a structureless sensitive film with a reflecting surface of mercury behind it, stated to be based on the theory of heliochromy set forth by Zenker in 1868 and later by Rayleigh and on Wiener's demonstration of stationary waves.

Further observations, *Comptes Rendus* cxiv., 961 ; cxv. 575. Proceedings Roya Society, vol. lx., p. 10. Proceedings Roya Institution, April 17th, 1896.

1891. DR. W. ZENKER.

Eder's Jahrbuch, 1891, p. 294-303 ; 1893 p. 114-121.

In these memoirs the author discusses the various methods—especially the interference methods—from theoretical points of view, and defends the Lippmann-Zenker theory agains the criticism of Dr. Stolze and others.

1892. G. MESLIN.

Mentioned by Bothamley in "Photography Annual," 1893.

Use of a bichromated albumen or gelatine film as in the Lippmann method, reduction taking place at the maxima of the stationary waves and the colours appearing on moistening or wetting the film.

1892. E. DE SAINT FLORENT.

Bulletin de la Société Française de Photographie, 1892, p. 661.

Ordinary gelatino-bromide plates exposed under a coloured original and fixed without being developed, give colour images, the transmission colours being complementary to those by reflection, but such colours usually disappear on drying the plate. Better results are obtained by treating the plate with nitrate of silver before exposure. Similar results on bichromated colloid films are described.

1893. A. and L. LUMIÈRE.

Bulletin de la Société Française de Photographie, 1893, p. 249.

Describes the preparation of a fine textured gelatino bromide emulsion for the Lippmann process.

1893. EDWARD VALENTA.

Photographische Correspondenz, 1893, p. 577.

Emulsion for, and details of working the Lippmann method.

1894. EUG. DUMOULIN.

Les Couleurs reproduites en Photographie Deuxiéme Edition. 58 pages. Paris, 1894. Gauthier-Villars et Fils.

A short general account of chief methods, with some historical notes.

1894. H. KRONE.

Die Darstellung der Natürlichen Farben durch Photographie, 120 pages, Weimar, 1894, K. Schwier.

Lippmann's method is referred to as subject to certain false renderings by moisture in the film and other conditions. The use of the mercury mirror, though requisite when the best results are required, may, however, be dispensed with. Exposure beyond that required lowers the purity and intensity of the colours. This work is a very carefully written history of heliographic experiments and research.

1894. R. NEUHAUSS.

Photographische Rundschau, 1894, pp. 295, 328, and 360.

Discusses details and working of the Lippmann method—the method, if properly carried out, rendering colours satisfactorily. Light beyond the range of the visible spectrum, whether infra red or ultraviolet, sometimes causes a green colouration, and a similar appearance is sometimes noticeable where the exposure has been inconsiderable.

1894. EDUARD VALENTA.

Die Photographie in Natürlichen Farben mit besonderer Berucksichtigung des Lippmannschen Verfahren, 79 pages. Halle a S 1894, Verlag von Wilhelm Knapp.

This work is one of especial interest as including the results of researches and experiments by the author.

1894. DR. H. W. VOGEL.

Das licht im Dienste der Photographie. Berlin, 1894. Oppenheim.

In this work, pp. 134—249 and in other places is much original and collated information bearing on heliochromy.

1894. E. J. WALL.

Gave two lectures on Photography in Colours before the affiliated photographic societies. These are published in the *Photographic Journal*, 1894, pp. 245 and 290; and in the *Amateur Photographer*, June 22 and July 20, 1894.

1895. A. BERTHIER.

Manuel de Photochromie Interferentielle. 169 pages. Paris, 1895. Gauthier-Villars.

1895. J. JOLY.

Method of Photographing in Natural Colours, a paper read before the Dublin Royal Society, June 26, 1895. *Transactions*, vol vi. (Series II.) and *British Journal of Photography*, December 6, 1895, p. 774.

General considerations on the three-colour process. Special reference is made to that form of the process in which one sensitive plate is used, and in front of this is placed a screen ruled in three colours, a screen not quite similar being used in viewing a positive from the resulting negative.

The screen for taking the negative is described as *orange*, green and violet; while the viewing screen is described as *red*, green and violet. The author does not appear to explain his preference for orange in taking that element of the negative corresponding to the red sensation, but presumably his reasons are similar to those which led Louis Ducos du Hauron in 1868-1869 to prefer an orange screen to a red screen in making up the triplet of red, green, and violet (*see* p. 41 of Ducos du Hauron's

"Couleurs en Photographie," Paris, 1869, Marion). It is interesting, however, to note that Ducos du Hauron's earlier proposal as regards the ruled screen (*see* page 56 of the work mentioned), differed somewhat from those of Dr. Joly. In a note addressed to the *Photogram*, March 1897, Professor Joly, without giving particulars, somewhat vaguely says, "The screen used in obtaining the negative is not lined in the same colours as are borne upon the screen ultimately used in viewing the positive. The first screen carries the three colours requisite to give densities of image upon the plate corresponding with the degree in which the various wave lengths affect our three-colour sensitive nerve systems. The viewing screen carries the three fundamental sensation colours, which alone are excited in, or conveyed by, the nerves."

1895. AUGUSTE AND LOUIS LUMIÈRE.

Revue Général des Sciences Pures et Appliquées. Dec. 15, 1895.

Application of diazotype for making the elements of the three-colour heliochrome.

1895. R. NEUHAUSS.

Photographische Rundschau, 1895, p. 353.

Mercury used in Lippmann's process appears to exercise a deleterious action, and the film should not remain in contact with it longer than is necessary; moreover, the plate should be developed as soon as practicable after exposure.

1895. G. H. NIEWENGLOWSKI and A. ERNAULT.

Les Couleurs et la Photographie. 370 pages. Paris, 1895. Société d'Editions Scientifiques.

General scientific and historical summary.

1895. OTTO WIENER.

Farben Photographie durch Körperfarben mechanische Farbenanpassung in der natur. Wiedemann's *Annalen der Chemie und Physik*, 2nd vol. for 1895 (Vol. 55 new series), page 225-281.

In this monograph of 56 pages the author endeavours to throw light upon the nature of the coloured images upon silver haloids as described by Seebeck, Becquerel, Poitevin, and others, and he formulates a new theory as to the way in which non-interference direct heliochromes are formed.

A first necessity was to discover a reliable means of distinguishing between interference colours in a heliochrome and body or pigmentary colours. This means was found in an observation through a right-angled prism in a way elaborated by the author, and is based on a shift of the line of the colour boundaries when the colours are the result of interference action.

Colours obtained by the method of Becquerel on a chlorinised silver plate proved to be in the main due to interference, rather than to a pigmentary colouring, but when chloride of silver in a flocculent mass was used, as in Seebeck's experiments, the colouration was pigmentary in its nature. Such pigmentary effects show the same colour whether viewed by reflected light or transmitted light. As bearing on such effects as can be obtained without the reflecting surface (silver-plate), it proves, as might be expected, that in Becquerel's method pigmentary colour is produced to a certain extent, although the effect is in the main due to interference.

The clue to a right understanding of the formation of pigmentary products in the case of the Seebeck effect is to be found in the researches of Carey Lea, on the coloured haloids or sub-haloids of silver. The material in the plate forms coloured compounds under the various spectral rays; but up to the present time there has been no explanation why the coloured compound corresponds to the rays which produce it.

The view of the author is that under the action of light there is a potentiality of producing the various coloured bodies (query sub-haloids of silver), and indeed there is always a general production of these various coloured bodies. Any given colour tends to survive under radiations corresponding to itself, because it itself best reflects that radiation, absorbing it least, and therefore being least affected by it.

As an illustration of this action one spectrum was thrown across another, and it was seen that each colour tends to destroy tints other than its own.

Wiener sets it down as a probable general law that:—Coloured illumination acting on suitable material, generates pigmentary bodies of corresponding colour.

The colour adaptability of caterpillars and other forms of life probably depends upon the presence of some colour-sensitive substance and the survival of the product corresponding in tint to the surroundings.

1896. MACFARLANE ANDERSON.

Photogram, September, 1896, p. 227.

An article bearing on the ruled colour screen method. It is stated that Anderson anticipated some of the recent introducers of the method.

1896. I. W. BENNETTO.

Photogram, November, 1896, p. 273.

A summary of various opinions on the results obtained by Mr. Bennetto is to be found in the above.

1896. CAPTAIN COLSON.

Photography for July 23, 1896, describes a method by Captain Colson in which prints obtained from coloured glasses on what is termed celloidin paper are fixed by being kept in contact with a sheet of blotting paper impregnated with ink containing gallate of iron.

1896. F. W. LANCHESTER.

Amateur Photographer, October 16, 1896, p. 318.

Mr. Lanchester interposes a grating, with spaces less than the bars, between the lens and the object, and a dispersing prism is adjusted at any convenient position between this grating and the sensitive plate. Each gap in the grid now gives a short but extremely broad spectrum and these spectra become a many-tinted equivalent of the three-coloured screen. The reconstitution of the colours to the eye might be possible with some similar spectral device or a coloured screen.

1896. LIEUT.-COL. ST. FLORENT.

Bulletin de la Société Française de Photographie, 15th May, 1896, page 252, and 12th June, 1896, page 287.

Celloidine paper (collodio-chloride paper, presumably) is tinted by light, restored by a bath containing iodine and exposed under a coloured original, then fixed in a 6 per cent. hyposulphite of soda bath. The colours produced by exposure disappear in the fixing bath, and it is essential that they should completely disappear. The print is washed and dried, then exposed to the sun or to a gentle heat, when the colours reappear; but yellows are almost always rendered as red.

1896. E. J. WALL.

Notes on Three-Colour Printing. *Photographic Journal*, Jan. 31, 1896, p. 100.

1896. C. L. BOTHAMLEY.

An account in *Photography*, June 4, 1896, of the applications of the diazotype process to produce three colours on a single surface. Processes stated to be the invention of Lumière and Segewitz.

1897. J. A. C. BRANFIL.

British Journal of Photography, February 26, 1897, p. 142.

A suggestion based on the method of three-colour heliochromy on one plate under a screen plotted out in lines (or other pattern) in three colours. Mr. Branfil proposes that, in taking the original negative, a diaphragm should be used having four perforations, three of these being covered with a red, green, and blue-violet window respectively, and the fourth being left uncovered. A ruled screen must be so adjusted in front of the plate as to cast pinhole images of the diaphragm apertures, and a suitable screen must be used in making three-colour printing surfaces and a key, from the negative.

1897. A. GRABY.

Photogram, February, 1897, p. 38. Translation in abstract of paper from *Comptes Rendus*, "In Natural Colours."

A method of heliochromy on a single surface of silver chloride, exposure being made in contact with various re-agents. It appears to be assumed that red, blue, and yellow sub-chlorides of silver are actually or potentially in the film before the exposure to the coloured image, and the abstractor says:—

> "Under the influence of blue light, the blue sub-chloride is not sensitive, and remains the same; but the red, if mercuric chloride be present, takes up chlorine and is converted into the blue. If chromic acid be present also, the yellow becomes oxidised to blue, so that only blue remains.
>
> "Under yellow light the chromic acid is not affected, but the blue and red—especially the former—are bleached, losing their chlorine and amalgamating with mercury.
>
> "Under red light the red sub-chloride remains unchanged, but the blue is changed by the red orange rays into the red sub-chloride.
>
> "White light produces blue or greenish yellow, according to whether the paper is exposed in the dry or moist condition."

The method appears to be one of a kind which accords generally with Wiener's theory.

1897. Louis Ducos du Hauron.

Photogram, March, 1897, p. 86. Portrait and biographical notice by his brother Alcide Ducos du Hauron.

It is stated that Du Hauron's first results were exhibited before the Photographic Society of France on May 7th, 1869, and many persons believed the specimens to be fraudulent. It is not stated whether these results were by that form of the three-colour method in which three separate negatives are used, or that in which a single plate is exposed behind a three-coloured screen. Both methods are explained in Louis Ducos du Hauron's book, published by Marion in 1869.

1897. Leon Vidal.

Photographie des Couleurs, 92 pages, Paris, 1897, Gauthier Villars et Fils.

Treats principally of three-colour heliochromy.

1897. H. Watzek.

Amateur Photographer, February 26, 1897, p. 164.

Application of the three-colour process of heliochromy to direct "carbon" or gum-aquatint printing.

1897. Sir Henry Trueman Wood.

Photography in Colours (letter). *Journal of the Society of Arts*, Jan. 29, 1897, p. 158. *The Times*, Jan. 30, 1897.

Production of Colour by Photographic Methods. Paper read Feb. 24. *Journal of the Society of Arts*, Feb. 26, 1897, p. 278.

A general study of the problem, and summary of progress to the present time. Statement as to the Dansac-Chassagne process as far as it had been made public.

1897. Alcide Ducos du Hauron.

"La Triplice Photographique des Couleurs et l'imprimerie," Paris, Gauthier-Villars (488 pages).

A full account of the researches of his brother Louis, and his method of three-colour printing. Descriptions are given of several devices for producing colour by three negatives and three coloured glasses, by a triple-colour line screen, &c. (For extracts relating to early work see 1859.)

Miscellaneous.

*ELBEUF TECHNICAL SCHOOL.**

Her Majesty's Consul at Rouen states that ther
is at Elbeuf a very thorough technical school, whic
is said to contribute not a little to the success of th
industry of the town. The primary object of thi
school is to form practical managers and foremen f
the woollen weaving, and spinning and dyein
industries. The courses followed are preparatory an
technical, each occupying two years. The theoretic
or preparatory course is divided into a study of (
elementary and applied mathematics; (2) industri
physics; (3) industrial chemistry; (4) machine drawin
and (5) general industrial mechanics. The practic
course comprehends (1) the study of all texti
materials; (2) the preparatory treatments of woo
(3) spinning and carding; (4) every operation
weaving, including a study of weaving machinery
(5) a practical course of chemistry and the dyeing
cloths; (6) the sizing and finishing of tissues: a
(7) the setting up and fitting up of factories and the
machinery. For the carrying out of these practic
courses and for the illustrations needed in t
theoretical, the school is supplied with (*a*) a sm
gallery containing all the principal machines used
the woollen and cloth making industries. The
machines are worked by steam, and the gallery
lighted by electricity; (*b*) a chemical laboratory a
dyeing house where the pupils are able to carry
the dyeing of wools and tissues, and to see practic
illustrations of their theoretical teaching; (*c*) the
is also a drawing office, a carpenters' workshop,
cabinet de physique containing apparatus illustrati
the course of practical physics; and finally a sm
museum exhibits specimens of work performed by t
pupils in the different shops. This technical scho
with its elaborate fittings, is supported by the fe
paid by the pupils and by the municipality, and it
subsidised by the Conseil-Général or County Counc
The fees paid sound very moderate to English ea
but on the other hand the hours of work are lo
Work is from 8 a.m. to noon, and from 2 p.m.
6 p.m. throughout every term, and there is no h
holiday in the week, but ten days are given at East
and the long vacation in summer lasts nearly t
months. The school is only for day boarders, a
the fees are as follows:—For pupils whose domici
or that of their parents or guardians, is in the to
of Elbeuf, 60 francs (£2 8s.) for the first year, a
80 francs (£3 4s.) for the second year of the prepa
tory class, and 200 francs (£8) for both years in t
technical course. The fees for those whose domic
is the Department of the Seine Inférieure are
francs (£4 16s.), 160 francs (£6 8s.), and 300 fra

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* In the *Journal*, vol. xxxii., p. 1056 (1884), there i
notice of the efforts made by the Industrial Association
Elbeuf to found this school.

£12) respectively. For those whose domicile is in any other French department 240 francs (£9 12s), 320 francs (£12 16s.), and 400 francs (£16). All foreigners pay 360 francs (£14 8s.) for the first year of the preparatory course; 480 francs (£19 4s.) for the second year, and 600 francs (£24) for the technical course. In the support given to the school there will be found a singular instance of the skilful methods by which German manufacturers attract custom, and of the apparent sacrifices they make to retain it; for Consul O'Neill says that the costly machinery with which the shops of this school are itted were supplied at a specially low, almost nominal cost by German manufacturers, and that German wholesale chemists now supply gratuitously he colours required in the chemical laboratory and dyeing sheds. It is true that German and Belgian manufacturers have also furnished the greater part of he machinery of the newer and larger factories of Elbeuf, so it may, perhaps, be safe to assume that after all they have not been losers by the double ransaction.

General Notes.

Munich International Art Exhibition.—Further particulars and papers have been received rom the Foreign-office, through the Science and Art Department, respecting the seventh Art Exhibition to be held at the Crystal Palace at Munich, from the 1st June to the end of October. Application for space should be made at once, and he time for receiving exhibits is fixed from the oth April to the 1st May. Works of art in the ifferent branches—Painting, Sculpture, Architecture, Engraving, and Works of Art-Industry—are admissible to the Exhibition. Works of the last class an only be admitted by personal invitation from the Central Committee. The juries of the various ollective exhibits determine what works shall be dmitted. An illustrated catalogue of the Exhibition will be published.

The Population of Greece.—The *Economiste 'Orient* has lately given the definite results of the ast census of Greece (1896), comparing them with hose of the previous census taken in 1889. The ctual figures are 2,430,807 inhabitants in 1896, and ,187,208 in 1889, thus showing an increase of 43,599 persons in this period. The population in he principal departments in 1896 was as follows, the orresponding figures for 1889 being in each case ated in brackets:—Attica and Bœotia, 310,380 57,764); Achaia and Elis, 236,251 (210,713); Messenia, 205,798 (183,232); Larissa, 181,269 68,034); Tricala, 176,773 (142,143); Acarnania nd Ætolia, 170,555 (162,020); Arcadia, 167,902 48,285); Argolis and Corinth, 150,578 (144,836); hocis and Phthiotis, 147,297 (136,470); Laconia, 135,441 (126,088); Cyclades, 134,737 (131,508); Corfu, 124,578 (114,535). The remainder is distributed among the departments of Cephalonia, Zante and Arta.

French Wine Production in 1896.—The total wine production of France amounted in 1896 to 44,656,153 hectolitres (hectolitre = 22 imperial gallons), as compared with 26,688,000 in 1895, an increase, therefore, of 17,986,000 hectolitres over that year, and 14,139,000 hectolitres above the average yield of the last ten years. In Algeria, 4,350,000 hectolitres were produced, and in Corsica 300,000, thus bringing the total yield up to 49,000,000 hectolitres. The production of wine from raisins amounted to 888,010 hectolitres, against 758,114 in 1895, and of *vin de sucre* 1,426,531, as compared with 1,425,960 hectolitres in the preceding year. The quantity of cider produced was 8,074,392 hectolitres, as compared with 25,587,000 in 1895. As regards the yields of the various departments, Hérault showed the greatest production—7,623,000 hectolitres; then comes Aude with 3,609,000, Gironde with 3,354,000, Pyrénées-Orientales with 2,038,000, Rhone with 1,968,000, Saone-et-Loire with 1,530,000, Loire Inférieure with 1,300,000, and Yonne with 1,076,000 hectolitres.

Immigration into the United States.—The annual report of the United States Commissioner-General of Immigration for the fiscal year ended June 30, 1896, shows that there arrived in that country 343,267 immigrants, of whom 340,468 were permitted to land, and 2,799 were debarred and returned to the countries whence they came, at the expense of the steamship companies by which they were brought. The increase in immigration on the preceding year amounted to 84,731. Those denied admission into the United States included 2,010 who were likely to become public charges, and 776 who were held to be contract labourers. There were also returned 238 who had become public charges within a year after landing, some, if the cause of falling into distress existed prior to arrival, at the expense of the steamship companies responsible for their transportation, the others at the expense of the immigrant fund. It is estimated that the money brought with the immigrants amounted to at least 5,000,000 dollars, and was probably much in excess of that figure, since only those having less than 30 dollars are required to disclose the exact amount, and it is known that very many bring the savings of years in order to buy land and build houses. The heaviest immigration of the year was from Italy, 57,515 over fourteen years of age; Ireland furnished 37,496; Russia, 38,188; Austria-Hungary, 57,053; Germany, 25,334; Sweden, 18,824, and Portugal, 2,067. There was a decrease in Japanese immigration, only 1,110 having landed in the country during 1896.

Liberian Coffee.—The production and export of Liberian coffee is becoming a subject of great concern to the farmers of the Republic. The phenomenal increase in its production is worthy of consideration. The coffee exported during the fiscal year, 1896, amounted to 600,000 pounds, while the exports for the year ended June 30th, 1896, amounted to 3,000,000 pounds. Farmers, merchants, and people generally have turned their attention to coffee growing. While no American ships touch at any Liberian port, yet more than one-fifteenth of the coffee produced is shipped to the United States *viâ* Liverpool. Coffee is the largest export, yet palm oil, palm kernels, piassava, and rubber are shipped in great quantities. It is asserted that if ships from the United States touched at Monrovia, Bassa, and Cape Palmas, half of the imports would be American, and, in turn, the exports would go to the United States, as the people, with the exception of the few Europeans residing in Liberia, prefer American produce. The reason for this preference is that the people are immigrants from the United States, and in habit and life are American. It is stated that a direct line of steamers from New York or Boston, touching at Monrovia once in two months, would be a paying enterprise.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

APRIL 28.—"Asbestos." By ROBERT H. JONES.

MAY 5.—"The Railway to India." By C. E. D. BLACK. SIR FRDERIC J. GOLDSMID, K.C.S.I., C.B., will preside.

MAY 12.—"Motor Traffic: Technical Considerations." By Sir DAVID SALOMONS, Bart. JOHN FLETCHER MOULTON, F.R.S., Q.C., will preside.

MAY 19.—"London Water Supply." By PERCY F. FRANKLAND, Ph.D., F.R.S.

MAY 26.—"Silver and Prices: the Economic drain of Debtor Nations." By MORETON FREWEN, B.A.

INDIAN SECTION.

MAY 6, at 4.30 p.m.—"Kafiristan: its Manners and Customs." By SIR GEORGE SCOTT ROBERTSON, K.C.S.I. (late British Agent at Chitral). FIELD-MARSHAL LORD ROBERTS, V.C., G.C.B., G.C.S.I., G.C.I.E., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday Afternoon, at 4.30 p.m.:—

MAY 4.—"The Arctic and Antarctic." By AUBYN TREVOR-BATTYE.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock:—

APRIL 27.—"Delft Ware." By Dr. J. W. L. GLAISHER, F.R.S.

MAY 11.—"A Half Century of Line Engraving, 1780-1830." By GEORGE CLULOW.

CANTOR LECTURES.

Monday Evenings, at half-past 4 o'clock:—

LEWIS FOREMAN DAY, "Design in Lettering." Four Lectures. May 3, 10, 17, 24.

MEETINGS FOR THE ENSUING WEE

MONDAY, APRIL 26...Sanitary Institute, 74A, Margaret-stree W., 8 p.m. Professor Henry Robinson, "Sewera and Sewage Disposal."

Surveyors, 12, Great George-street, S.W., 8 p. Mr. W. H. Payne, "Local Authorities and t Building Laws."

Actuaries, Staples-inn-hall, Holborn, E.C., 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, APRIL 27...SOCIETY OF ARTS, John-stre Adelphi, W.C., 8 p.m. (Applied Art Sectio Dr. J. W. L. Glaisher, "Delft Ware."

Royal Institution, Albemarle-street, W., 3 p Dr. Tempest Anderson, "Volcanoes." (Lecture

Medical and Chirurgical, 20, Hanover-square, 8½ p.m.

Civil Engineers, 25, Great George-street, S. 8 p.m. Annual Meeting.

Statistical, in the Theatre of the United Serv Institution, Whitehall, S.W., 5½ p.m. Henry W. Wolff, "Savings Banks at Home Abroad."

Photographic, 12, Hanover-square, W., 8 p.m. T. Bolas, "A Practical Demonstration of Gl blowing at the Lamp."

WEDNESDAY, APRIL 28...SOCIETY OF ARTS, John-str Adelphi, W.C., 8 p.m. Mr. Robert H. Jo "Asbestos and Asbestic: with some Account the Recent Discovery of the latter at Danville Lower Canada."

Geological, Burlington-house, W., 8 p.m. 1. Charles Callaway, "The Origin of some of Gneisses of Anglesey." 2. Capt. H. G. Ly Miss C. A. Raisin, and Miss E. Aston, "Note a Portion of the Nubian Desert South-East Korosko."

Royal Society of Literature, 20, Hanover-square, 4½ p.m. Annual Meeting.

Mechanical Engineers, 25, Great George-str S.W., 7½ p.m. Mr. Leslie S. Robinson, " chanical Propulsion on Canals."

Mining and Metallurgy, Geological Muse Jermyn-street, S.W., 8 p.m. 1. Mr. John D junior, "Gold Mining in Norway." 2. Wilfred Wybergh, "Graphic Assay Plans."

THURSDAY, APRIL 29...Chemical, Burlington-house, W p.m. 1. Dr. H. C. Myers, "Monochlordip conic Acid and some Condensations." 2. Mr. A. Caldecott, "The Decomposition of Pyrites."

Royal Institution, Albemarle-street, W., 3 Rev. Canon Ainger, "Some Leaders in the P Revival of 1760-1820." (Lecture I.—Cow Burns, Wordsworth, and Scott.)

Sanitary Institute, 74A, Margaret-street, W., 8 Mr. Charles Mason, "Scavenging and Dispos House Refuse."

Zoological, 3, Hanover-square, 4 p.m. An Meeting.

FRIDAY, APRIL 30...Royal Institution, Albemarle-street, 8 p.m. Weekly Meeting. 9 p.m. Prof. J Thomson, "Cathode Rays."

Mechanical Engineers, 25, Great George-st S.W., 7½ p.m. Mr. W. G. Walker, "Experim on Propeller Ventilating Fans, and on the Ele Motor driving them."

SATURDAY, MAY 1....Royal Institution, Albemarle-street, 3 p.m. Rev. J. P. Mahaffy, "The Greek The according to Recent Discoveries (Lecture 5 p.m. Annual Meeting.

Journal of the Society of Arts.

No. 2,319. Vol. XLV.

FRIDAY, APRIL 30, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

APPLIED ART SECTION.

Tuesday, April 27, 1897; JOHN SPARKES in the chair.

The paper read was on "Delft Ware," by Dr. J. W. L. GLAISHER, F.R.S.

The paper, with the report of the discussion, will be printed in a future number of the *Journal.*

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The fourth meeting of the Congrès International de l'Enseignement Technique will be held this year in London, commencing on the 15th of June next, at the invitation of the Society of Arts, and of the Worshipful Companies of Drapers, Fishmongers, Goldsmiths, Merchant Taylors, and Clothworkers.

The Congress will be opened at 11 o'clock, on the 15th of June, by an address from the President, the Duke of Devonshire, K.G.

The subjects for discussion at the Congress will include:—

Technical Education:—

1. Advanced Instruction. Polytechnics, Universities, Colleges.
2. Secondary Instruction. Higher Technical Schools; Secondary and Intermediate Schools; Evening Schools.

Commercial Education:—

1. Advanced Instruction. Colleges; High Schools and Institutes of Commerce.
2. Secondary Instruction. Commercial Schools; High Schools; Classes for Adults.

It is not proposed to deal with elementary Technical or Commercial Education. The education of both sexes will be included. Further information will be issued at a later date.

The Executive Committee will be glad to receive offers of papers coming within the scope of the subject as above defined. The papers must be in the hands of the Secretary not later than the 29th May.

The papers will be printed and distributed at the meetings. They may be in French, German, or English, and speakers may make use of any of these languages.

All communications relating to the business of the Congress should be addressed to the Secretary, Society of Arts, John-street, Adelphi, London, W.C.

PRACTICAL EXAMINATIONS IN MUSIC.

The Practical Examinations in Vocal and Instrumental Music will be conducted by Mr. John Farmer, Balliol College, Oxford, and Director of the Harrow Music School, Examiner, and Mr. Ernest Walker M.A., Mus.Bac., Oxon, and Mr. Burnham Horner (organ), Assistant Examiners, at the House of the Society, and will commence on Monday, 28th June.

Particulars can be obtained on application to the Society.

Proceedings of the Society.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 28, 1897; Professor SILVANUS P. THOMPSON, D Sc., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Garibaldi, Joachim A., 21, Church-place, Gibraltar.
Gissing, Captain Charles Edward, R.N., 40, Albany-mansions, Albert-bridge-road, Chelsea-reach, S.W.
Levenstein, Ivan, Hawkesmoor, Fallowfield, and 21, Minshull-street, Manchester.
Mackay, Sir James Lyle, K.C.I.E., 7, Seamore-place, Mayfair, W.
Malthus, Colonel Sydenham, C.B., Dalton-hill, Albury, Guildford.
O'Shaughnessey, James Edward, St. Mark's-square, Bangalore, S. India.
Rhodes, William, Beverley, Chatsworth-road, West Norwood, S.E.
Stirrat, John, Town Hall, Rangoon, Burma.
Taylor, H. W., Semaphore-chambers, Kalgurli, Western Australia.

Williams, Arthur Edward, Dagenham Dock, Romford, Essex.
Wood, Walter C., care of Messrs. Buchheister and Co., Ningpo-road, Shanghai, China.

The following candidates were balloted for and duly elected members of the Society:—

Bowen, Horace George, Bank of England, E.C.
Chalmers, George, St. John del Rey Mines, Morro Velho, Brazil.
Elliott, George, 10, Oceanic-avenue, Belfast.
Fortlage, H., Breakspeare-house, College-road. South Dulwich, S.E.
Rabbidge, Richard, 32, Poultry, E.C.

The paper read was—

ASBESTOS AND ASBESTIC: WITH SOME ACCOUNT OF THE RECENT DISCOVERY OF THE LATTER AT DANVILLE, IN LOWER CANADA.

By Robert H. Jones.

When the Canadian form of asbestos, which is technically named chrysotile, was first discovered, about a score of years ago, I had occasion to go over to Quebec to examine what, to all intents and purposes, was a new mineral, and report upon its qualifications and capabilities. I then became so impressed with its manifest importance, that I determined to make a special study of it, as well as of asbestos generally.

My inquiries after, and searches for, asbestos have naturally led me into many remote and untravelled parts of the world; and some few years ago I published a book on the subject, since which time, whenever any new discovery has been made, I am frequently sent for to advise on the special quality found, the best mode of working it, and the proper channels in which to dispose of its produce.

First, I will say a few words on its nature and historical relations.

Asbestos is one of the most marvellous productions of inorganic nature. It is a physical paradox: a mineralogical vegetable, both fibrous and crystalline, elastic yet brittle, a floating stone, which is as capable of being carded, spun, and woven as wool, flax, or silk.

Occupying the apparent position of a connecting link between the animal and vegetable kingdoms, it would appear to possess some of the characteristics of both, while being strangely different from either. In appearance, it is as light and feathery as thistle or eider down, while, in its crude state, it is as dense and heavy as the rock which carries it. Ostensibly as perishable as grass, it is older than any animal or vegetable life on earth. So little, indeed, is it affected by the dissolving influences of time, that the action of unnumbered centuries, by which the hardest rocks are worn away, has had no perceptible effect on the asbestos found embedded in them. While some portion of its bulk is composed of the roughest and most gritty materials known, it is as smooth to the touch as soap or oil. Apparently as combustible as tow, the fiercest heat cannot consume it, and no combination of acids will affect the strength of its fibre, even after days of exposure to its influence. Yet, notwithstanding its extreme delicacy, a single strand of it can be spun to weigh less than an ounce to one hundred yards of thread, and a cloth may be manufactured from its fibres which shall weigh less than eight ounces to the square yard, and still retain a fair tensile strength.

Perhaps, not the least remarkable of its many inconsistencies, is that, while in some form or other, it occurs in nearly every country in the world, it is never found to repeat itself. It nowhere appears, even in strata of the same age, in any two countries precisely alike, in appearance, texture, or general character, or in any two parts of the same country, or even of the same district. It varies greatly in accordance with different conditions of climate and locality, as well as of the nature and surroundings of the rock in which it is found. One remarkable difference, occasioned by variations of constituents, is shown in the sample of fibre from South Africa; and another, almost as startling, appears in one of the Australian varieties, which is of a bluish eucalyptus green. In some other cases, the variation may be the result of formation under different temperatures, or different rates of cooling.

Under the Romans, it was believed to be of vegetable origin, the silky appearance and unctuous feel of the fibre contributing to the idea that it was an organic substance. Herodotus tells us that his countrymen made a kind of cremation cloth of it, in which they enwrapped the bodies to be consumed on the funeral pyre, in order that the ashes and unconsumed particles of bone might be kept separate from the remains of the fuel, so as to be preserved in vases, or in the family urn. Pliny took it to be of vegetable origin, calling it *linum vivum*, but he says these were rare and costly cloths, the funeral dress of kings.

One of these shrouds was found in a sarcophagus in the Via Praenestina in 1702, perfectly intact, and can be seen to this day in the library of the Vatican, where it was placed by order of Pope Clement XI.

The religious care also with which the Romans guarded the sacred fires in the temples of the gods from extinction, caused them to make use of asbestos as an auxiliary, the flame having been first enkindled by means of a crystal sphere.

The lamps of the Vestal Virgins were furnished with asbestos wick, the fine fibres of which, by their contiguity, form small tubes or channels, which serve to draw up and feed the flame with oil, themselves remaining unconsumed.

Kircher, the German philosopher, formerly made a wick of this kind, which he says he used for two years without injury, until at last it was destroyed by accident; but Pontoppidan tells us he made one, but was obliged to discontinue its use, because he found he could not get so clear a light from it as from the common wick. The Greenlanders use them, and so do the Labrador Esquimaux. I have seen these last using them in Labrador, in their soapstone lamps. Asbestos wicks are used in England in some of the lighthouse lanterns, and are now being arranged for more general use.

A very interesting account of the mining for and use of asbestos is given in Marco Polo's "Travels in Great Tartary" (A.D. 1280), which is too long for quotation here, but the matter is so faithfully described that the account of it might have been written yesterday.

The late Prof. Ansted, of King's College, in his little work, "Rambles in Search of Minerals," tells us that certain tribes of Indians make dresses of asbestos, which they cleanse by throwing them into fire; but, unfortunately, he says nothing as to the whereabouts of these unknown tribes. When speaking of "tribes of Indians," one's thoughts seem naturally to turn to the Red men, dwellers on the American continent, but it is absolutely certain that those spoken of could have been none of these. Even the bare supposition that any tribe of savages could have accomplished the extraordinarily difficult process of spinning and weaving this efractory mineral fibre into a cloth, is just as wildly improbable as to imagine that any uman being could have dreamt of using it s a covering for his bare skin. The diffiulty of doing this—that is, of spinning it—is seen by placing a single fibre under the microscopic lens, where it looks as firm and rigid as a bar of steel, and shows none of the callosities or other irregularities of silk—and none of the imbrications, which make the spinning of wool so easy and natural. It is curious also that none of the old authors who speak on this subject attempt to describe the weaving process. We have now, however, ample proof that it was managed by intermingling some organic fibre, probably flax, with the asbestos fibre, and then, with a liberal supply of oil, weaving the two together, after which they burned out both the vegetable fibre and the oil. Naturally, the cloth so made must have been but a poor skeleton of what such a cloth should have been; and what is a little extraordinary is that this was precisely the process by which asbestos cloth was woven in modern days until, after long and repeated experiment, a more effectual way was found of accomplishing the operation by means of very ingenious and intricate machinery.

All these historical matters are very interesting, but asbestos to-day is of more importance to the human race than ever it has been before in the whole range of history.

In modern times—little more than five-and-twenty or, perhaps, thirty years ago—it was scarcely known, except in the cabinets of the curious, but now it finds its way into every workshop where steam is employed.

In recent times it was intended, in the first instance, to be applied in Italy for the manufacture of a special clothing for the protection of firemen; and afterwards, Paris set an example, which was followed by London after conclusive evidence of its feasibility. Captain Shaw says that there are certain cases in which it may be indispensable to traverse the flames in order to reach some particular spot, and it was for the purpose of preserving persons who find themselves in such circumstances that the Italian experiments were made.

In the general application of asbestos in modern times to the several branches of practical mechanics and industrial manufactures, it is to Italy that we are indebted for leading the way. Previous isolated experiments are recorded, but these do not seem to have been followed up until long afterwards. In the last century, for instance, Professor Bruckmann of Brunswick was successful in the manufacture of paper, on which he caused to be printed a natural history of the mineral, some copies of which book are said still to be preserved in the museum of Wolfenbuttel; and early in the present century, a Madame Perpenti of Cone successfully employed asbestos, not only in the manufacture of paper, but of cloth also, and a kind of coarse lace, with many other articles of a useful character. It is specially noteworthy in regard to this cloth that in her make Madame Perpenti used no other fibrous ingredient as an admixture. Her process simply consisted in softening the asbestos in water, beating and rubbing it, and finally separating the fibres by means of a comb furnished with fine steel points.

I have only been able to refer to a few of the earliest adaptions of this mineral fibre, because it would take far too long to explain or give any attempt to enumerate them, or even give more than a general mention of some few of its uses in steam, hydraulic and electrical machinery, in which a multiplicity of packings, &c., now find a place. The various coverings also designed for the protection of boilers and pipes and for the economy of fuel are specially important and very numerous, as well as its varied applications to engineering and electrical purposes. It is also of great importance in many matters connected with warfare, and in medical and hospital practice, though in the latter it is, fortunately for us, not used as it is said to be in China, as a medicine. In regard to its use as lint, the editor of the *Engineer* remarked, some time ago, that although we may never reach the time when our under-garments shall be purified by fire, instead of by the laundress's art, yet, short of this, many uses now fulfilled by materials—the thorough cleansing of which cannot be secured without their destruction — may possibly be better served by asbestos. Of these, the cleansing of lint is one, with medical bandages, operating cloths, &c.

In these days of high pressure and liner records across the ocean, asbestos is of supreme importance to the marine engineer, to enable him to obtain jointing and packing materials upon which absolute reliance can be placed. The natural properties of the mineral admirably adapt it for such purposes as these, its native lubricity rendering it additionally valuable; by its use a perfectly pure packing can now be produced through which the rod slides with a minimum of friction.

Its numerous uses for building purposes may also be referred to, many of which are rendered compulsory in the United States, where asbestos is far more largely used than it is here. Its usefulness in the form of drop curtains is generally understood there, and in New York and elsewhere is made compulsory, as, it is to be hoped, it will be some day so rendered here. A part of one of these curtains which withstood the fire at the Queen's Theatre, Manchester, in August, 1890, I will show you. This was made by the United Asbestos Company of London, and was given to me by the secretary and manager of that company.

For cold storage buildings and refrigerating chambers, it is simply invaluable. For the preservation of meat and other provisions, brought from distant lands, specially constructed ships containing the necessary refrigerating apparatus and chambers are now in universal use.

In beetroot sugar refineries in France, Germany, and Austria, fine asbestos cloth is in universal use for filtering the saccharine juices. It is necessary also in chemical laboratories for straining and filtering acids and alkalies, which would quickly destroy any ordinary filtering paper; and it is specially useful when the liquid to be filtered is of a caustic or strongly acid nature, or where it may be desirable that the filter, with the residue, should be ignited without consuming the filter, or where the residuum is to be dissolved off the filter by acids or other solvents. Asbestos filter bags are better fitted for this purpose than those made of any othe material; they last longer, retain the hea better, and are more easily purified. Fo filtration purposes generally, asbestos ha proved to be so eminently adapted that i forms a material adjunct to the filtering medi in all the more important filters now in use.

Being one of the most refractory substance known, asbestos is in use in a variety of way for the lining of furnaces and the backing o stoves.

For insulation purposes, it is much in us by electrical engineers in the form of mill board in the construction of dynamos.

A special quality of asbestos paper is als made for wrapping battery plates in, an gloves are made of asbestos cloth for holdin red-hot crucibles, and to enable the enginee to handle the wires with comparative impunity

As already mentioned, asbestos in moder times was first brought into experimental us in Italy, and soon afterwards the Unite Asbestos Company, having acquired th

Italian works and mines, started the manufacturing business in England.

It was not long afterwards that there appeared amongst us a totally distinct variety of the mineral, which had not long before been discovered in a wild and unpopulous part of the province of Quebec, in Lower Canada; and though it was not very favourably received at first, its economic value could not long be ignored, and experience has shown that while the two varieties are totally and curiously unlike, each has certain special uses and advantages, and, indeed, a combination of both is occasionally to be preferred to the use of either one of them separately.

The difference between the two forms of mineral is remarkable. The asbestos of Italy s asbestos properly so called. It is a variety of hornblende, or pyroxene, while that of Canada is nothing more than serpentine, which occasionally, but only rarely, assumes a fibrous character. When it so occurs, its mineralogical name is chrysotile. In form, structure, and general appearance, the two are as strangely dissimilar as any two minerals can possibly be; yet, in chemical composition they are remarkably alike, and, in many of the uses to which they are put they may be said to be absolutely identical. Indeed, to such an extent is this the case, that by far the larger part of what is sold and used for asbestos, is in reality chrysotile, which is so used and sold with full knowledge of the fact that it is so, and without any pretence of concealment or disguise whatever. The essential difference between the two, is that Italian asbestos is anhydrous, while the Canadian chysotile, being serpentine, is invariably hydrous, its water of composition amounting to between 13 and 14 per cent.

The first Italian mine was opened in Lombardy in 1866, and the first Canadian mine, at Thetford, in Lower Canada, in that part of the country which is known as "The Eastern Townships of Quebec," about the ear 1877. Some considerable time before his date, the existence of the mineral there was known to geologists, and it was also xhibited at the International Exhibition in London as early as 1862, though, at that time, t was not much regarded, except by scientists, nd by them chiefly as a mineralogical uriosity. But this first mine was no sooner pened, though its success at first was by no means promising, than others quickly followed, nd prospecting for fresh finds was extensively arried on in every part of the province.

Somewhere about this time, a good many new mines were started, but in no case did the produce of any one of them come up to that of Thetford, which still maintains its old supremacy, both in regard to the quality of fibre and the quantity produced.

Among these new mines, was one which was discovered near to the pleasant village of Danville, in the township of Shipton, a good many miles from the headquarters at Thetford. This mine, from its first discovery, was worked, with a fair amount of success, by a Mr. Jeffrey; but at no part of its career, up to the time of its closure—which happened shortly before the death of the proprietor—was it looked upon as of any particular importance, though its produce was invariably good and generally considered to be second only to Thetford, and much beyond anything to be found at Black Lake.

Mr. Jeffrey, whom I well knew, gave his name to the mine, or rather it was always known—and to this day is generally spoken of as—the "Jeffrey Mine." He was a well-known character among asbestos men, somewhat obstinate and self-willed, and strictly a man of the old school—independent in his ideas, by no means highly educated, and never much inclined to move out of the old grooves; indeed, his style of work might be said to have been that of the "rule of thumb." As the years rolled on, he became hampered with contracts and other matters, which presently landed him in pecuniary difficulties to such an extent that at last he found himself under the necessity of assigning the whole of his property to trustees, for the benefit of his creditors; very shortly after which the mines were closed.

Some time subsequently, proposals were made to Mr. Boas, of St. Hyacinthe, either to take over the mines or to render financial assistance, with a view to a resuscitation of the works.

Mr. Boas was a man of an entirely different calibre to that of the late owner. He was not an asbestos man, nor did he make any pretence to a knowledge of mineralogy, but all throughout the province he was highly esteemed for his uprightness, shrewdness, and sound common sense. On going over to inspect the Jeffrey mine he was soon satisfied of the character of the fibre, which, with proper management, he was assured could be made to yield valuable returns. But what struck him most of all was the apparently unusual character of the rock which carried the fibre, the texture of which was such as he had never remarked before. It was certainly quite different from the ordinary run of asbestos-bearing serpentine which he had met with anywhere else, and it then occurred to him that it might be possible to convert such a rock into many important uses, instead of allowing it to be carted away and thrown on the dumps as waste. After reflecting on the matter, he set about making a series of experimental trials, the result of which showed him that he was entirely correct in his conjectures. He therefore decided to take over the property, and, as soon as the necessary arrangements were completed, set about erecting such buildings and fitting up such improved machinery — nearly all of which was automatic in operation—as were an astonishment to the country, and then began to work the mine as it was never worked before. His efforts in this direction soon began to be crowned with the success they deserved. His untiring energy and activity brought him many visitors to see the operations carried on at the mine, while his friends and neighbours were not slow to perceive that, at the very time when his predecessor was most in want of funds, a veritable gold mine lay unheeded beneath his feet. Some began to blame Mr. Jeffrey for being unaware of this, but if he were to blame, to how much greater an extent were all those numerous scientific men, geologists, mineralogists, mining engineers, and others who, in course of that time, had called purposely to inspect the mine, report upon, and write about it? Every one of these may be presumed to have had better, that is, more highly educated eyes than he could have had. The rock was of precisely the same texture as it had always been, but no one before this time had ever remarked anything peculiar about it. The time had evidently not yet come. The extreme importance of the matter remained unknown, until it suddenly encountered the (unpractised) eye of keen intelligence, when at once the whole thing became so manifestly self-evident that, as was the case with the famous egg problem solution, the spectators could only wonder where their eyes had previously been.

Before the time of the publication of my book on asbestos and its uses, I had more than once visited and inspected every mine in the eastern townships of Quebec, and was well acquainted with their different peculiarities and capabilities, with the single exception of this particular one at Danville. Why I neglected this I cannot tell; but so it was. Mr. Jeffrey several times invited me to go over there, but never once, in my many visits to that part of the country, did I ever avail myself of the opportunity of doing so. It was a long way from the other mines, and no doubt I was under the impression that this was mainly like all the rest, and scarcely worth the time and trouble of a special journey. At the same time, I would emphatically disclaim all idea that, had I done so, I should have discovered anything special about it, any more than Mr. Jeffrey himself had done, or any one of the numerous scientific or professional men who had already inspected and written about the mine. As an asbestos man, it is quite conceivable that my attention would at once have been attracted to the important consideration of the number, extent, and quality of the veins and seams of asbestos, to the neglect of any special peculiarity, altogether undreamed of before, in the texture of the surrounding rock. On the other hand, Mr. Boas was, as I have said, not a mineralogist or an asbestos expert, and was, therefore, untroubled with any preconceived notions. He simply looked on the matter with the keen eye of unprejudiced common sense. When I was told first of the discovery, I remembered that something like it had often occurred to my mind, but my thoughts were always directed to the question of the possibility of so crushing the rock, as to see a way to the extraction of the numerous small veins and stringers, which are commonly seen in asbestos mines, but which I afterwards found are by no means prevalent in that of Danville. This seemed to be scarcely worth the expense which would have had to be incurred, as it could have been only accomplished by the aid of specia machinery; and when the description of wha Mr. Boas had done was first reported to me, could only regard the story as the effect of a too vivid or sanguine imagination. But when at length I reached Danville I was strangely undeceived. On going down into the pit to examine the result of a blast, before any of th *débris* was touched, I was literally astounded. Instead of, as I had expected, finding th result to be as 1 in 50, or even 1 in 100, could plainly see that, regarding the mass o rock as a whole, it was undoubtedly and at th very least 90 per cent. of pure asbestos, o asbestos-like material, the like of which I ha never seen before. And when I subsequentl saw this very rock, after it had passed th crushers and sifters, falling automatically without any handling whatever, from th cyclones as pure asbestos fibre, white as the driven snow, I thought the sight of that well worth the journey from London to Canada.

I have here for your inspection a sample of the most useful of the Italian ores, with a specimen or two of Canadian ore from Thetford and East Broughton, so that you may see the strange mineralogical difference between the two species, also a sample of the Danville ore and fibre, with a lump of asbestic, which is the rock which carries the latter, and also a sample of the cleansed material, just as it falls from the cyclone, ready for use by the manufacturers. To these I would presently call your special attention in order that you may see in particular the wonderful nature of the rock itself, which is found at Danville. No lens is required, its very peculiar character being sufficiently obvious to the unaided eye.

In the Italian deposits, one often finds minute crystals of green coloured garnet, which the miners call the asbestos seeds (*semenze dell' amianto*). None of these are ever seen in the Canadian mines, but at Danville I have frequently found remarkable specimens of clear light-coloured translucent serpentine. I will show you a specimen of this, being part of a vein of pure silky fibre covered or protected by a rich delicate skin of a charming tint of light green as lovely as that of a newly expanded willow leaf in spring, yet this is in itself as clearly and compactly fibrous as that which is held compressed in the vein.

I suppose few things are better understood than this trade fact, that when any valuable or unusual commodity remains for a long time at an almost prohibitive price, on account of the difficulty of its production, so that manufacturers have been continually driven to the use of substitutes in place of the real thing; when this material happens to be, by any fresh discovery, suddenly brought down to a price within the reach of all the world, one invariable result follows. Such an impetus s given to the use of that commodity, and such an effective spur is applied to the inventive faculty, that an incredible number of uses for it are at once found, and the trade in it quickly advances by "leaps and bounds," ust as is already the case with this.

One remarkable fact in connection with the discovery of asbestic is that the firm which stands at the head of the trade—that is, which s the largest dealer in, and manufacturer of, asbestos and asbestos goods in the whole world—I mean the consolidated firm of the H. W. Johns Manufacturing Company of New York, after a full investigation of all the facts connected with this matter, proceeded to make contracts of such an extent that the immediate duplication of the whole of the Danville machinery was necessitated, although it was then already by far the most extensive and effective in Canada.

With regard to this machinery, I will only say that it is unique, and well worth the inspection of any one to whom the opportunity of seeing it is afforded. The building in which it is housed is a substantial five-storey structure, so arranged by the hillside that the laden wagons can drive straight through the doorways and along the passages, to deliver and take up their loads at the required points, on four out of the five stories of the building, which is admirably ventilated and lighted in every part by electricity. The roof is covered with asbestos, and considerably more attention has been given to external appearance than I have ever seen before in mining buildings. Another building stands close alongside as an annexe, the lower part of which is utilised by the engine and boiler house.

At the front entrance to the fourth floor are seen the huge lips and jaws of the mighty crusher, which lies recumbent beneath. These lips and jaws are ever moving and at work, as one might almost imagine them to be those of a cow peacefully and slowly chewing the cud. As the masses of rock are hauled from the bottom of the pit, they are placed on cars and moved onward over the rails to the front of the crusher, where they are dumped on to the iron platform, near to the working jaws, towards which they slide and into which they gradually enter and disappear, a lump of a ton weight being drawn in with apparent ease and quietly masticated by the huge monster, which weighs 48 tons. The mastication consists of so carefully crushing the rock as in no way to injure the fibre.

There are four other crushers, two of which are duplex, making seven in all, the least powerful of which weighs seven tons. These are situate in various parts of the machine's anatomy; the machine itself being apparently so far a sentient animal, that it requires no assistance whatever in the digestion of its food, but hour after hour and day after day its process of digestion goes continuously on, working gradually, smoothly and automatically, until after the rock has left the crushers and passed through several sets of Cornish rolls, over a gigantic picking table, and has undergone the ordeal of no less than twelve cyclone pulverisers with a whole series of fans, exhaust blowers, revolving, shaking and jigging screens, with the rest of the complicated apparatus, the spectator, as he proceeds onward, presently finds himself standing at the foot of a long gently sloping table. To this there is imparted a constant jigging motion, so that everything which touches it is irresistibly impelled to join in the dance, and slides slowly along jigging, jolting and jumping, onwards and downwards, until it reaches the lower end of the table; by which time the fluffy fibre is entirely separated from all gritty particles, when, as these last approach the edge they are gradually jerked over to be dealt with further on; while the fibre is acted upon by a strong upward current, by which it is drawn, or sucked, into a pendent receiver, after the fashion of pieces of paper carried by a draught up the chimney, where it disappears from view. Now, if we leave the concluding process and proceed to the lower floor, we shall see the result exuding from the orifice of a pipe, and falling in flakes of immaculate whiteness into bags placed there to receive it, in which it is firmly compressed and fastened up. The bags, which hold 100 lbs. each, are then loaded into waggons waiting in readiness to receive them, for conveyance by the Grand Trunk Railway on the road to their ultimate destination.

Thus, from the time that the rock is drawn from the pit, until the fibre reaches the manufacturer, no handling or interference of any kind is needed, but everything is carried on systematically and automatically, the sole exception being the employment of a single lad, whose duty is to watch the cyclones and see that they do not become clogged by reason of the fluffiness of the fibre.

Another very important and remarkable matter for consideration is that a majority of the more clear-sighted owners of the other mines, seeing at once the impossibility of any competition with Danville at anything like present or recent prices, determined for the present at any rate, without burning their ships, to close their works and await the progress of events. Their wisdom in following this course is at once apparent, when we see at what a heavy cost we arrive at the value of the crude asbestos, and its expensive character, both in labour and the extent of land required for dumping ground. The removal and disposal of the *débris* of the mines, which is incessantly increasing, is far and away the most expensive and troublesome part of the whole system of asbestos mining. In this regard, it may be worth mentioning what a well-known mining engineer says on the subject. Mr. Klein, the manager of the American Company's mine (formerly Wertheim's), who is an experienced and thoroughly reliable man, recently delivered a lecture at the Asbestos Club at Black Lake, the members of which are no inexperienced novices, but all mine owners, managers or engineers—men who would quickly have contradicted his statements, had contradiction been possible. In this lecture, while dealing with this very important part of the subject, which had necessarily to be referred to, the lecturer stated that in almost every case he had found the amount of waste in the mine to be understated in the returns and reports; that in the very best mines it could not be put at less than fifty tons of waste for every single ton of asbestos produced. And here I can well imagine a smile rippling over the faces of the audience, for the lecturer immediately began to qualify this statement by saying that, in his own belief, a hundred tons would often be much nearer the mark, and that even a hundred and fifty was by no means unknown. But even this is not all; the enormously-increasing mounds of waste, piled up around the various mines, have generally become intolerable to such an extent that in two cases extraordinary measures have had to be taken to get rid of them at any cost.

In the case of the United Asbestos Company, the form of their land at Black Lake is of so inconvenient a character that, in the course of time, it was found they could dump no more without trespassing on their neighbour's land; so, in order to prevent a stoppage of their work, the company was under the necessity of building an inclined tramway 3,800 yards in length, by means of which cars could be drawn up the mountain side as far as the shores of Cariboo Lake, where, for the present, they could find room for dumping.

In another case, the extent of the company's holding was seriously curtailed by the decisions of the local and superior courts in the actions brought against them by thei neighbours for encroachment. This was o more far-reaching importance to them than the very heavy pecuniary compensation they were compelled to pay for the quantity o asbestos they were alleged to have taken fron their neighbour's land. At any rate, thes decisions of the courts left them but one way out of the difficulty, and that was to purchase land on the far side of the track of the Central Quebec Railway, across which they had to build a line of their own, and over which their dumping cars are now drawn by means of an overhead bridge. By the adoption of this costly expedient alone have they at last been enabled to get rid of their waste rock, the constant accumulation of which was shutting them out in every other direction.

This is one of the ordinary expenses incident to asbestos mining which so greatly tends to keep it at such a high price. It can therefore readily be seen that if once this enormous expense was swept away, how effectually the prime cost of the mineral could be reduced, more especially if that waste were waste no longer, but actually a substance convertible into money. This is precisely the effect of the discovery at Danville.

Now, after what has been said, two main questions will occur to the mind of every one. First, why cannot the waste of the other mines be utilised in the same way as that of Danville? And secondly, if there be any special reason why it cannot, then for how long a time is it likely that this particular mine will remain unexhausted? To the last question I reply, without any hesitation, that unless some entirely new discovery be made, the Danville mine cannot possibly be exhausted by any imaginable process of working for very considerably beyond the period of one hundred years. In fact, the mine to all intents and purposes, is practically inexhaustible. And as to the other point, none of the mines elsewhere produce asbestic, the nature of the rock being entirely different from that of Danville. I have already shown why the various mines differ in the quality of their fibre, and have no doubt that in one or two of them something approaching to this may be produced, but to what extent is as yet unknown, and whether or no it will return a profit also remains to be seen. At one mine the process was tried with somewhat similar machinery, though only on a small scale. In the first place about two-thirds of the rock was found to be so manifestly inapplicable that it was at once rejected. The remainder of the dumping ground was then picked over, and a good part of the rock passed through the crushers, sifters and cyclone, with the result that from this portion of selected rock some bags of "float" were obtained which was not much like that o Danville. No sale could be found for it, and the mine is now closed.

Well, what after all is asbestic? A dictionary will tell us that the word is an adjective, meaning something "of or belonging to asbestos;" but, as used here, it is a substantive, applying to that part of the rock which remains after the richer veins of asbestos have been extracted from it. This remainder is purely a fibrous material, which clearly shows its serpentinous origin. And here a very remarkable fact may be mentioned. The knoll-like mound in which the Danville mine is situate, is one only of a series of similar mounds which run a long distance through the country—all through the townships of Melbourne, Cleveland and Tingwick, and, after all these knolls had been carefully inspected, no single one of them was found to carry any fibrous material but this Danville one alone, in which all the fibre found in this part of the country would seem to be concentrated.

On the question of its production, as we have already stated, asbestos is nothing more than serpentine, that is serpentine in its peculiar fibrous form, which it assumes much less frequently than is generally supposed; and, when it does occur, has many peculiarities. Most minerals, as we well know, are sensitively affected by the nature of their surroundings, and especially by their more intimate associates. Even gold is no exception to this rule, as witness the effect of its association with bismuth; but I know of no mineral which is so readily affected by its associates as serpentine. This is sensitive to such an extreme degree that it might almost be called a sentient rock. From this point of view, nothing like sufficient attention has been paid to it by asbestos men, though everyone can see its alterations in every asbestos mine in the country. As a matter of fact, so many, so various, and so supreme are the changes brought about by its variable associates, that, although in some form or other asbestos can be found in nearly every part of the world, there are, as already remarked, in no two countries any two mines to be found which produce exactly the same class of fibre; and this is true, not only of any two countries, but of any two parts of the same country, and even of any two parts of the same district. In reality, it is never and nowhere the same. The difference may be slight, and may be either in colour, form, or texture. Doubtless, either the colour of the rockor the fibre itself is so regulated that the one affects, or is affected by, the other; but to show the fact of the existence of this peculiarity, one has only to compare the fibre and its containing rock—such, for instance, as it is at Thetford—with that which is produced at Black Lake, and either of these with the produce of Broughton, Lake Nicolet, Brompton Lake, the Ottawa Valley, or, over and above all, with the special material which occurs at Danville, and which, at present, stands alone.

Before this time—provided the veins were long enough or wide enough, and the fibre in them sufficiently silky—no one paid any regard to minutiæ. Asbestos was simply asbestos, just as serpentine is serpentine. But in future much more attention must be given to this vital matter, for upon it will depend the existence and utility of many mines. In fact, the day is rapidly approaching when far more attention must be given to the study of mineralogy generally by mine owners and their superior *employés*, as well as to the special qualificatians of the local serpentine. It is to the neglect of these important matters that the new discovery has fallen in their midst with the suddenness of a thunder clap.

Now, a few words on the particular uses of asbestic as apart from asbestos. The first idea which occurred to the discoverer was to pulverise it, and to convert it in its pulverised state into a cement or plaster. A few bags were sent to the manufacturing firm of H. W. Johns and Company for trial, when they found it to be so admirably adapted for this special purpose, and so unique from many points of view, that it was at once named "the king of wall plasters." In its manufacture it requires the use of neither hair nor sand, its own fibres furnishing a perfect substitute for the former, and the pulverised rock supplying all that may be required of the latter. During the short time since its introduction, although the number of men employed in procuring it is unusually large, and the machinery employed in its preparation entirely automatic, the supply is found to be unable to meet the demand. This plaster, being composed exclusively of asbestos, is both fireproof and a non-conductor of heat, so that a room plastered with it is not only protected from fire, but at the same time is kept warmer and more comfortable than if dressed with any other known plaster. It also effects a saving of something like 25 per cent. in the fuel employed; and being also a non-conductor of sound, bedrooms may be relied upon, if the spaces beneath the floors and over the ceilings be filled with rough asbestic, to be free from overhead or internal noises. Its use also is invaluable, for the same reason, in hospitals and sick rooms, as well as in music and concert rooms. It is moreover odourless and vermin proof, and being a natural filter, if a pail be upset in the room above so that the underneath ceiling be wetted, it dries again as before and leaves no mark or stain. It is also as elastic as fibrous, so that there is no fear of any crumbling, chipping, fracture or displacement. Even if a nail be driven into it, it will enter as readily as into a deal board. Neither the heat from any stoves or furnaces, nor even the "settling" of a building, will have any effect upon the asbestic. It will adhere to metal or glass, and I have seen it applied as a covering to a tin pipe, its adhesive nature preventing any crack or split when bent round the pipe; and when walls are papered or painted with it, all danger from fire from that source is entirely avoided. When walls are plastered with it, no sooner does it become dry than all danger of having to do it again after the settlement of the building is entirely done away with.

I called at many of the huge buildings now rising about New York and Montreal, following the example of Chicago, and saw its practical use while building was going on. A coating of rough asbestic was first applied with a trowel, just as it would be with any other plaster, it might be on brick, laths, or plain boards; and, when this is dry, it forms a coating very much like the asbestos felt-board now so much in use in America and Canada. This rough coating is then surfaced over with a superior quality of asbestic called the "Finish," which dries with a fine appearance not unlike marble, and with a good polish. Its cost is about the same as that of good sand and lime plaster, which its covering capacity greatly exceeds, while its mixing is so simple, and its application so easy, that it is found to be practically cheaper.

There is a peculiar danger to be feared in all these lofty buildings, which are now so much the fashion over yonder, which specially arises from their framework. Both iron and steel are so much affected by heat that, if a conflagration should occur near to one of these Babel-like buildings, the girders would become so affected that they would be likely to bend downwards, in doing which they would assuredly draw the uprights towards them, and cause a general collapse of the whole structure. I saw the action of this immediately after the destruction of the Tuileries and other large buildings in Paris in the time of the Commune. The plan adopted was to pile the furniture, and such other combustible matter as was at hand, in the centre of the principal room, pour petroleum over it, and then set fire to the heap. The great heat soon caused the girders to sag downwards, drawing the sustaining walls inward, so as to cause speedy and irretrievable ruin. In the case of the monster buildings alluded to, if the metal skeleton were protected by brick, and the brick plastered with asbestic, all danger from the source indicated would be avoided. This is the plan adopted at the Waldorf Hotel in the Fifth Avenue, and many of the modern buildings in New York.

Asbestic is also applied, by the manufacturers already mentioned, to the making of a special roofing material of a perfectly light and cool character, which is so effectually proof against burning sparks and cinders that, in every case of exposure to fire it has proved to be a complete protection. It is specially applied to the steep or flat roofs of factories, foundries, warehouses, railway buildings, cars, &c. It is suitable for all climates, has been used in every part of the States, and in parts of South America and Europe, for a sufficient length of time to show its superiority over corrugated iron wherever used.

In 1861, the roofs of Kingsford's Oswego starch factory were covered with the original asbestos roof coating, which is still in good condition. This is now vastly improved in strength and durability by the use of asbestic, and specially improved asbestic roofing has now become so important, and in such rapidly increasing demand, that it is manufactured at the enormous rate of *over two miles per day*.

For paper making, asbestic is so admirably adapted that it has now taken the lead in the United States of any other commodity used for the purpose, whether of wood, straw, or any kind of pulp. Wherever it has been tried, it is found to carry everything before it, and there can be little doubt that as it becomes more generally known its use will become universal. The demand for it is already so great that in the course of last year the H. W. Johns Manufacturing Company had to put up an immense new building adjoining their other manufacturing premises at Brooklyn, for the special purpose of producing asbestic paper, more especially for building purposes. Here I saw in operation a new machine capable of producing it of a very superior quality at the rate of from 30 to 50 tons per day, and of a width of 130 inches. This new building was specially erected in consequence of the vast discovery of asbestic fibre at Danville, which enables the manufacturers to enter into competition with any kind of wood or straw pulp paper now used in the trade.

There can be no doubt that, properly prepared by careful working, the shortest Danville fibre will before long become an important factor into the paper trade generally, it being of a pure white colour and of remarkable fineness, while the trade can buy it at a price much below that of any other material now in use by them. During the last year the increased consumption of asbestos by this firm was, notwithstanding the depression in prices and trade generally, nearly four times that of any former period, and this was entirely attributable to the Danville discovery.

When any of these revolutionary changes occur in any particular line of business, as is now taking place in the asbestos industry, matters are always disorganised, and many people seem to be involved in ruin, but things very soon right themselves. The new discovery has given such an impetus to the trade that no day passes without new applications of asbestos being brought to the notice of manufacturers, and very shortly more asbestos will be required and used than ever before; and when things have quieted themselves a little, and old practices have become discarded, means will be found for utilising the now standing properties and (as I believe) making them more flourishing than ever.

Perhaps no one who seriously regards the subject-matter of the paper read before them this evening will fail to see the great importance of it, and how extensive a field is now laid open to the discoveries of scientific men. The present discovery was not due to science at all, but to the unaided intelligence of keen common sense. Its extraordinary value is shown by the fact of the promptness with which the entire capital of the company recently formed was secured by the manufacturers and the few capitalists who had looked into the matter, rather than by the general investing public, to the great majority of whom asbestos—and all that relates to it—is, in a great measure even now, practically a sealed book.

DISCUSSION.

Mr. GRAHAM HARRIS said, as an engineer, he was interested in asbestos, and he thought this paper certainly deserved great credit. The idea that a rock, such as serpentine, could be woven into a cloth, not only flexible, but having the other qualities of cloth, taking dye, as he believed it would, which might be worn even by ladies, was certainly a poetic idea. Like all materials which had some one special quality in a very marked degree, asbestos was sure to come to the front, because being fire-resisting it met one of the greatest needs which the engineer had to satisfy in his daily practice. He should have liked to hear a little more about that wonderful machinery at Danville, which seemed to have revolutionised the trade. They heard of the crushers into which the stone was passed at one end, and of the table at the other end with the cyclones, where the material, which was not asbestic, was rejected, and the asbestic was drawn away as fibre, but they had not heard much of what went on in between, except that there were sieves, jiggers, and various pieces of moving machinery. He should have liked to hear something about that, because it would have enabled one to judge of the process by which this serpentine rock was turned into the beautiful fibrous material, capable of being woven into cloth, of which samples were shown. He was quite sure that, though the uses of asbestos were at present rather narrow, they were going to broaden very considerably in the near future.

Mr. JAMES CUNNINGHAM, of Montreal, said he was intimately acquainted with the Danville mines, and deeply interested in the subject of asbestic. As Mr. Jones had told them, being composed of pure asbestos, a non-combustible material, asbestic was fireproof, in confirmation of which he would mention a test made in Washington at which he was present. Last year the United States Government, being desirous of securing a fireproof plaster for a new building being erected for the Post-office, and asbestic being brought to their notice, determined to test it. A small structure was built and plastered with asbestic half an inch thick, filled with firewood, and then a fire was lit and allowed to burn for half an hour; when, on the plaster still glowing from the intense heat, a stream of water from a 1½ inch nozzle was turned without having the slightest effect. A similar experiment had been recently made in Montreal with equally satisfactory results, and he hoped before long to see one in London. Mr. Jones said that asbestic, being fibrous, was elastic, and was also a capital non-conductor of heat and sound, and would keep a house warm in winter and cool in summer, and all that he could vouch for. It had been his privilege from the inception of this discovery to visit the chief cities of the United States and Canada and interview the principal architects and builders; it was a radical innovation, and like all new materials, was quite justly subject to criticism and opposition; but he had invariably found a keen interest displayed, and wherever it had been specified and used, both architect and builder had been astounded at the work performed. Of the hundreds of buildings plastered with asbestic which he had reported upon, there was not one which had not borne out all that had been claimed for it. He had just returned from Glencoe, where Sir Donald A. Smith was building a mansion, and so thoroughly had he been convinced of the superior qualities of asbestic, that he insisted on the contract for parian being cancelled, and asbestic used in its stead; and there, as everywhere else, all were astonished at its beauty, elasticity, and strength. From the great success achieved in so short a time in the Uuited States and Canada, he felt sure that in a year or two the demand would be very great indeed, and it was well that the supply was practically inexhaustible. One important feature was the impossibility of adulteration and consequently inferior work. Any architect specifying asbestic must get it and nothing else.

Captain FOX (London Salvage Corps) said this substance appeared to be a most estimable article, well worthy the attention of architects and all interested in buildings. As he had listened to the paper he almost felt that his occupation was gone, for it seemed that even if a fire did break out it might be kept within reasonable limits by the use of this material. He did not say that it would reduce warehouse fires, but it would confine within reasonable limits fires which broke out in private houses. Besides it seemed capable of thoroughly artistic treatment; the surface was most beautiful, taking a high polish, or it could be painted upon. He could certify to its fireproof qualities, having made a small experiment for his own satisfaction.

Mr. J. ALFRED FISHER (United Asbestos Company) said he had been connected with asbestos for a good many years, and he must congratulate Mr. Jones on the paper, which showed that he was a thorough master of the subject. When Mr. Boas came to England a few months ago he came to his (Mr. Fisher's) office, and he was rather surprised to find the direction in which the United Asbestos Company was working in connection with the utilisation of asbestos for building purposes. Mr. Boas and the Asbestos and Asbestic Company had taken a very important step in the right direction; for many years it had been his idea that asbestos was to be utilised chiefly not for engineering but for building purposes, and he thought Mr. Boas had done wisely in introducing asbestic in this cheap and effective form for this purpose. His (Mr. Fisher's) company had also been working in the same direction, and he was glad to say that they were able to cooperate with the Asbestos and Asbestic Company by furnishing it with a very artistic material, such a ras shown on the walls, called "Salamander," rhich was made entirely from asbestos, and which ave a beautiful and artistic finish to the material rhich Mr. Boas and his company were placing on the narket, instead of ordinary paper, or other comustible coverings.

Mr. F. W. FLETCHER said he had had occasion to nake small furnaces, for experimental purposes, of bestos cardboard, and he should think, from what ad been said about asbestic, that it would be very seful for this purpose if it could be supplied in heets or blocks. He might add, for the benefit of nyone who should experiment in this direction, that e had found considerable advantage in using a weak olution of sodium silicate, which helped to bind the ther material.

Mr. DYASON desired to add his meed of praise to he author of the paper, but remarked that this naterial did not appear to have been subjected to ny rigid chemical analysis, nor did they know how t behaved under extreme heat, such as that of the lectric furnace, or under extreme cold. For many ears he had been a visitor to the mortuary of one of he largest parishes in London, and it occurred to him hat asbestic might be very usefully applied in the onstruction of such chambers.

Captain R. C. ADAMS (Montreal) said he was peronally familiar with the mines which had been lescribed, and having met Mr. Jones in Canada, and aving repeatedly visited the mines, he might say a vord or two in endorsement of the statements in the aper. For several years he had been President and Vice-President of the General Mining Association of he Province of Quebec, and it had been his duty epeatedly to visit this district, and satisfy himself as o the value of the deposits. From his own personal nowledge, therefore, he could endorse what Mr. ones had said. He had visited the Danville Mine t the time Mr. Jeffreys owned it, when it was shut lown as a failure, and when Mr. Boas took hold of t, it was with a great deal of scepticism that he heard f the undertaking. That was the pretty universal pinion; but Mr. Boas was a man of genius, an poch-making man, one of those men who occaionally got hold of an idea, and, in spite of ll opposition, carried it on until it proved a vonderful success. When they heard the stories bout these deposits being so different to those of ll other mines, they were regarded with a great leal of doubt, and many feared there would be a iasco, but he was thoroughly convinced, from ersonal examination, that in the main the statenents were correct as to the extraordinary nature of he rock. He was there last fall, and saw the splendid nachinery and buildings which had been erected at a ost of £35,000. To show the thorough way in vhich the place had been built, and Mr. Boas's faith that the deposits would last for at least 100 years, he might mention that instead of laying the floors with planks in the ordinary way, they were all laid with 10-inch planks on edge. As to the way in which the work was carried on, there were hundreds of thousands of tons of waste rock which had been discarded under the old system, after the asbestos had been picked out. This was carried up to the hopper and thrown into the Blake crusher, and cracked to a size in which it could enter the cyclone mill. This was simply a cylinder in which revolved blades or beaters, like the fans of a propeller. These created an immense current of air, and all the rock that went into it immediately flew up, and by attrition and the beating of these blades, became pulverised. Then at the end of long tubes there was a fan which created a current of air, which drew the material upwards; then it fell by gravity, the heaviest in one bin, that a little lighter in the next, and the very finest at the end. In that way, without being touched by hand from the time it went into the hopper at the top, it all went on automatically. As to the amount of deposit, the machinery, and so on, Mr. Jones had not at all overstated the case. The only problem seemed to be how to make use of it. Any new material must of course be somewha slow of introduction, but he knew something of the people connected with this enterprise, and though he had no pecuniary interest in it, he had the greatest confidence that by their efforts all possible uses would be found, and that the enterprise would be eminently successful.

The CHAIRMAN said this subject was especially interesting as being connected with the Dominion of Canada, and seeing that there would be many scientific men visiting Canada next August in connection with the meeting of the British Association, he hoped their friends over there would arrange for an excursion to these mines at Danville. Two points on which he should be glad of a little more information had not been touched upon by any of the speakers. To him the main interest in connection with asbestos was from the electrical side, and he should like to ask Mr. Jones whether this new material, which he gathered contained 10 per cent. of water, was as good an insulator as anhydrous asbestos, or better; and, again, whether it was as porous. One defect of the old asbestos cardboard, from an electrical point of view, was that it was porous, and sucked up oil at the commutator, or sucked up water when used as a covering for wires, and he should like to know if this asbestic had any superiority in that respect. Then it was not generally known that asbestos was a magnetic body, so that a piece of asbestos millboard could be picked up by a magnet if it were sufficiently powerful; and the question was whether asbestic also had this property. It was very interesting to have a paper on a new natural product of such obvious commercial importance, both present and future. The Society of Arts had long devoted its attention, from time to time, to new products and their utilisation, and the literature of that subject was by no means despicable. When one thought of all the different materials which had been brought into use for the service of mankind, and how each one seemed to have its own uses mapped out beforehand, one was easily led away into a wide field of speculation. For instance, what would they do now without kieselguhr, Iceland spar, gutta-percha, india-rubber, Senegal pea-nuts, shark's-skin, amber, or mica; or, to go to manufactured products, without *papier maché*, celluloid, or the various alloys? Modern science, progress, engineering, and architecture were at the mercy, so to speak, of certain products, and every new product would obviously, in course of time, meet with new applications, and add to the resources of mankind. Here was a most remarkable product, and not the least interesting of its properties was that it could be made into paper. It was no exaggeration to say that the introduction of wood pulp for paper had degenerated that manufacture to such an extent that nine-tenths of all the books now being printed would certainly in a hundred years have disappeared into powder. The books of William Morris, printed at the Kelmscott Press, and a few others, would probably survive, and a hundred years hence people would say what splendid fellows there were in the 19th century; they produced admirable literature, and beautiful paper and printing. They would give us credit for being great masters of the art of printing, simply because all the inferior stuff had perished. Now they had a new material, more imperishable than the best linen paper, and probably the next great printer would use imperishable paper made from asbestos, and perhaps print with platinum black, so that the ink, as well as the paper, should be fireproof. But he must not pursue these speculations. He might remark, however, that the absolute beginning of the submarine cable industry was laid in that room by a paper, which was read in 1845, on the then new material, gutta-percha. They had now had a paper on asbestic, and perhaps, twenty years hence, there would be a paper read on some new industry, at present undreamed of, which had grown up out of this new product.

Mr. JONES said he was not able to answer the Chairman's question as to the electrical properties of asbestic, but probably Mr. Fisher could do so. With regard to magnetic qualities, asbestos and asbestic were identical.

Mr. FISHER said he should not think there would be any difference between asbestos and asbestic in their insulating properties, but he had not made any special experiments on that subject.

The CHAIRMAN then proposed a vote of thanks to Mr. Jones, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

MEXICAN TOBACCO.

Ever since the dawning of what is called th
"American Epoch" of Mexico, there has been
steady and continuous development in the exports o
that country. The American Consul at the City o
Mexico says, "That striking as are the facts wit
regard to the increase of the cultivation of coffee an
the growth in the United States of a great apprecia
tion of the Mexican berry and its sterling qualities
these can be paralleled in many points by th
development of Mexican tobacco." Although Franc
has not profited commercially by this increase, it i
only simple justice to say that it is due very largel
to Frenchmen and to the exiles from Cuba who
they employed. A French writer, Louis Lejeune
was the first to point out that the tobacco grown i
the upper valley of the Papaloapam River produce
leaves as fine, as silky, and even more aromatic an
perfumed than those of the "Vuelta Abajo" i
Cuba. He showed that the plantations in the Pin
del Rio district of Cuba were exhausted, and tha
not even the most lavish use of fertilizers coul
enable them to produce leaves of the real Haban
quality. He compared the western end of the islan
of Cuba to a dying fire, where one could find he
and there points of living flame, but everywhere el
ashes and blackened embers. M. Lejeune in h
pamphlet made an elaborate comparison of the rel
tive cost of starting a tobacco plantation in Cuba an
in Mexico, and showed that, supposing silver to be
par, which it was when he wrote, the expenses
the latter were only one half of the former, witho
taking into consideration the price of land or t
cost of transportation. He adjured his countryme
who were enterprising, not to wander off to Coch
China, but to establish themselves in Mexico
tobacco ptantations. Some did so, and at the la
French exhibition those who had followed his advi
received gold medals for the excellence of their pr
duction. For some reason or other the French Rég
did not, until the fiscal year 1894-95, accept Mexic
tobacco, and, therefore, France has lost the bene
to which it was fairly entitled through the energy a
skill of Frenchmen who created the initiative whi
has resulted in ranking the Mexican leaf with t
Habana. Prior to 1889 the export of Mexic
tobacco rarely amounted in value to 900,000 Mexic
dollars in any one year (say £90,000), but
1895-96 the value amounted to 1,700,0
dollars (£170,050). At first foreign countri
imported Mexican cigars, but they did n
give complete satisfaction, because boxes mark
"Colorado," "Colorado Claro," and even t
"Claro," when opened were found to conta
"Maduros" and even "Oscuros." The suppositi
was that this was due to negligence in marking t

oxes, or even to fraud, because the light-coloured igars are preferred as being milder. This was a reat injustice to the Mexican importers, who are nost careful on these points. The enigma was olved by the discovery that Mexican tobacco ripened vith remarkable rapidity, and that "Claros" became Oscuros" during the short transit from Vera Cruz r Tampico to New York. The remedy was clear. t was to import the leaf and manufacture the igars under climatic conditions that would pro-ong the ripening process. This led to a very brisk lemand for leaf tobacco, and the Indians in the obacco belt of Mexico were so foolish as to add corn hucks, grass dirt, and even stones to add weight to heir bales; especially was this so in the case of that ought and shipped to Germany. The consequence as that there was a reaction, and the buyers for oreign houses would not look at any tobacco that id not bear the inspection brand of some well-known rench, German, or Mexican house. Then the ndian growers were in despair and offered their obacco for the price of seedling tobacco. American uyers jumped at the price and thus the exportation o the United States for 1893-94 reached the figure f 382,767 pounds, as against 70,107 pounds for 891-92, but this was not maintained. Practically o wrapper tobacco is grown in Mexico. The leaf all "filler." This is a virtue to those who like a trong cigar, easily smoked, but it is a defect for the eneral consumer who likes a milder article. When igars were mostly made in Habana the wrapper as "Yara," and not the "Vuelta Abajo," for that ery reason. A comparison of the prices paid for exican leaf tobacco by the various importing ountries may be of interest. Germany, the chief nporter, pays 37 cents per pound; the United tates, 38 cents; England, 39 cents; Belgium, only cents, and France, only 25 cents per pound. The nest Mexican cigars go to Habana at one dollar 7 cents per pound; England gives 94 cents for exican cigars; France, one dollar 10 cents, and e United States, 88 cents. In Mexico the soil is deep that it is not necessary to plant a crop of rn after the crop of tobacco, and instead, the rowers raise a second or seedling crop. After e plant has been cut, a stalk or chute springs undantly, and from this stalk or chute spring nall and very mild leaves, about the size of a man's and. These are utilised by the manufacturers of garettes. To the factories in the country this bacco is sold at from 2 to 5 cents a pound. The garette tobacco is excellent and its reputation is very od. Colombia and Peru buy it in constantly increasing quantities at from 6 to 9 cents per pound, d Guatemala buys at 6 cents. All of the Central mericans and some of the South Americans buy e Mexican cigars and pay an average of 1 dollar cents per pound. In a word, says Consul ittenden, Mexico is not only one of the coming ffee countries, but is also a coming tobacco country. exico seems to be destined to wear the mantle of Habana in tobacco production, and once secured, it is safe to predict that it will never pass away, for the soil of the tobacco region is so deep as to be practically inexhaustible, being from 8 to 20 feet in depth, and in some places even 30 feet. Moreover its extent is probably one hundred times that of the Cuban tobacco region, when we take into consideration the fact that acre for acre the percentage of cultivated land at the present moment capable of producing tobacco of the very highest grade is greater in Mexico than it ever was in Cuba in its best days; we can from this easily see what will be the amount produced in the future. Mexico's resources in this direction are practically so great as to make it certain that it will become rich from its tobacco alone. No doubt the result will be finally to cheapen the "Habana" cigars, and put them within the reach of all. The tobacco lands of Mexico form an immense inverted capital **T**, the cross stretching from Tuxtepec (Oaxaca) and the upper valley of the Papaloapan through the southern portion of Oaxaca into the Tehuantepec highlands, and thence into the state of Chiapas; the upright of the **T** stretches from the valleys of the Colorado and the Trinidad rivers (which form the San Juan river) eastward to the San Andres Tuxtla Canton. The cream of the tobacco lands will undoubtedly be found in the valleys of the Colorado and Trinidad rivers, but chiefly the latter. The soil in these valleys is from 10 to 15 feet deep, and of the very richest quality, and is equally adapted for coffee or tobacco. It may be taken as axiomatic as regards Mexico that the land that is good for one is equally good for the other. To the eastward of the main valley of the Trinidad river, in the transverse valleys, the soil is even deeper than 10 to 15 feet, and here one finds mahogany trees of the most astonishing size and of the finest quality. This region is called Las Monterias de Caoba, and is very extensive. Transportation is one of the most important questions which the planter in Mexico has to consider. In the Trinidad region he is close to the National Tehuantepec Railway, and he can also raft down to Vera Cruz, which town is reached by the small river steamers that ascend the river from Tlacotalpam. He has two ports, Coatzacoalcos and Alvarado. Whenever the railway from Cordoba reaches Tuxtepec, it will undoubtedly be extended to Juili on the Tehuantepec line, and must traverse the Trinidad region, so that on the score of transportation one is reasonably assured being amply provided for in the present, with the probability of still more accommodation in the future.

THE JAPANESE SILK INDUSTRY.

Sericulture constitutes one of the oldest industries of Japan, its authentic history dating back as far as the early part of the third century. At that time silk fabrics were used extensively for the payment of

taxes, especially in the silk-raising districts. The different provinces whose inhabitants were engaged in the silk industry were divided into three grades, according to the quality of the silk and silk fabrics produced, and in the early history of the industry the provinces of Mikawa and Owari enjoyed the reputation of producing the finest quality of goods. The general conditions of Japanese farming are very conducive to silk culture, by reason of the fact that the spring hatching comes at a time when the farmers, who are almost the only class of people engaged in silk culture, have plenty of time at their disposal. Moreover, the hatching is always completed before the farmer finds it necessary to devote his attention to the cultivation of rice, the staple product of Japan, which circumstance in a measure accounts for the fact that silk cultivation is carried on to a greater or less extent in almost every district in the empire. As above stated, silk culture is carried on in every province in the empire, with the single exception of the Liukiu Archipelago. Mr. Robert P. Porter, formerly superintendent of the eleventh census of the United States, who has recently been conducting investigations into the industries of Japan, says that the culture of silk being a side occupation for most farmers, is in the generality of cases carried on upon a small scale, although the number of special sericulturists who devote their entire time to the work is steadily increasing. The manner of reeling cocoons is in the several less important districts very primitive, but machine reeling is gradually superseding the hand method. There were in 1893 only fifteen silk-producing districts in the empire where the filatures worked by machines exceeded 50, while those provinces where the aggregate exceeded 100 were as follows:—Nagano, 514; Gifu, 497; Yamanashi, 251; Kioto, 228; Aichi, 198; Ibaragi, 132; Yamagata, 109. As the total number of filatures of both kinds in operation in the country was 3,202, and the kettles used for reeling numbered 100,557, the average number of kettles per filature was 33. There were in the empire only six filatures in 1893 which employed over 500 girls, namely, three in Nagano, two in Fukushima, and one in Saitama. In this number were an equal number of machines and hand-reeling filatures. According to the statistics compiled in this connection, it would appear that about a third of the total number of filatures was steam in 513 cases; hydraulic in 1,151; and in the remaining 1,539 cases the power was furnished by men. Most of the machinery now in use in the principal silk districts of the country are what is known as two-skein reeling machines, whereby one girl can reel two skeins at the same time. Numerous foreign varieties of worms have been imported into Japan. The Korean variety is very vigorous in growth, and the cocoons it produces are similar to those of the *Aobiki* and *Akabiki* varieties, although somewhat smaller in size. The popularity of this variety has grown steadily since its introduction in 1885, and its culture is now quite extensive. T
French and Italian varieties seem for several reaso
unsuited to Japan, although cross-breeding betwe
the French and *Akabiki* varieties has proved ve
successful in a number of cases. The Chinese varie
has not proved a success in Japan, the growth bei
feeble and unsatisfactory, and the cocoons sma
The importation of cocoons from Japan was origina
undertaken by the enterprising silk merchants
Nagano, and in 1893 their imports aggregated 3
bales. The importation has, of course, continu
since that time, but no later figures are availab
Mulberry trees commence to supply leaves for t
raising of the worms about three years after plantin
and continue to do so for about ten to fifteen yea
when the stumps are removed and new saplin
planted. The mulberry fields of the governm
sericultural establishment at Nishigahara were plan
in 1887, and the yield of leaves per tan (one quar
of an acre) amounted in 1892 to 1,487,000 poun
and in 1893 to 1,641,000 pounds. It is estima
that a one tan (one quarter acre) field of mulbe
trees, when fairly grown, yields between 200 and
kwans (1,656 to 2,484 pounds) of leaves, which wo
be sufficient to feed one sheet of eggs; according
it is usually estimated that from 200 to 250 kw
(1,656 to 2,070 pounds) of leaves are needed
obtain one koku (4·96 bushels) of cocoons. T
market price of leaves is susceptible of the great
fluctuation in different seasons, and in various pa
of the empire. The growth of the manufacture
what is known as *habutai* silk has far surpassed
other branches of the industry, at least, during
last ten years. It originated in the town of Fuk
in Echizen province, and although the industry
since spread to Ashikaya and Kiryu and other no
weaving towns in the Kozuke province, Fukui
remains the centre of the industry. In olden ti
the province of Echizen was noted for a special s
of silk fabric known as *nosho tsumugi*, the manu
ture of which was started about 160 years ago an
still carried on. The growth of the manufacture
habutai is shown by the fact that while in 1890 th
were only 789 weaving establishments engaged
this industry, the number had increased in 1895
2,946, and the yards of habutai woven had risen f
1,744,000 to 12,912,000 in the same period.
value in the same way had increased from $748,00
$6,076,000. The vigilance exercised for the impro
ment of the habutai has been attended by
satisfactory results, as is attested by the numer
prizes which the weavers of Fukui and vicinity h
gained in both domestic and foreign exhibitions.
the exhibition held in 1895 in Belgium, the Fu
habutai received certificates of excellence an
medal, and on the occasion of the fourth Dome
Exhibition held in Kioto in 1895, prizes w
awarded to 52 out of 101 exhibitors. At the Wor
Fair at Chicago in 1894, prizes were also recei
The work of manufacturing habutai silk is divi
into four parts: twisting, dyeing, softening

aving, dyeing being needed for the manufacture of : figured habutai. The business of softening nsists, in addition to softening the cloth, of anging the length and breath, and also obviating fects which are likely to characterise the cloth. ter his work is concluded the softener imprints his mp or mark on the cloth, and prepares it for pection at the central office. There are eight fteners in the city of Fukui, and ten in the vicinity. ie habutai cloth for export usually measures fifty rds in length, but its breadth and weight vary eatly. Silk handkerchiefs constitute one of the incipal articles of export, the amount reaching more an 4,000,000 of silver dollars annually. These go ncipally to the United States and England. arious kinds of handkerchiefs are exported, but the ite variety with folded edges is in greatest demand. iginally crepes and other fabrics were used in the inufacture of the handkerchiefs, but latterly the inufacturers have utilised the habutai silk proced at Fukui, Kiryu, Ashikaga, and other points. lk handkerchiefs are produced almost exclusively the districts of Tokio, Yokohama, Odawara, fu, Nagoya, Yamanashi, Fukui, Kobé and Kayama, or in other words, the districts adjacent either Yokohama or Kobé, the principal ports of port. In accordance with the provisions of a law acted by the Imperial Diet of Japan, silk conioning houses have been established in the open rts of Yokohama and Kobé under Government ntrol, the management of these institutions being signed to the Department of Agriculture and Comerce. Numerous complaints have been made in e past that raw silk delivered at the open ports was t up to standard in fineness or in weight, and that ch defects could be easily concealed on inspection careless purchasers. The Government apparently eling that there might be some ground for these mplaints, and fearing that the trade in raw silk, iich is one of the most important articles of export, ould be affected, introduced and passed a law for e establishment of two silk conditioning houses iich would inspect and furnish a certificate on each nsignment. Both of these institutions have been ened and are now in operation. Their use is not mpulsory, and no charge is made for the examinaon or the certificate.

FRENCH CENSUS OF 1896.

A report on the subject of the French Census of 1896 is recently been issued by the Minister of the Interior. his states that since 1891 the number of communes in rance has increased from 36,144 to 36,170, and the imber of cantons has risen from 2,881 to 2,899. ccording to the census enumeration of the 29th arch last, the population amounts to 38,517,975. 1891 it was estimated at 38,343,192, so that an crease of only 175,000 has taken place during the period 1891-96. In the period 1886-96 the increase has been 299,072 persons, but taking the period 1891-96 the increase as stated above has been only 175,000. As compared with 1891 there has been an increase of population in twenty-four departments, as follows :—Alpes Maritimes, Belfort, Bouches-du-Rhone, Corsica, Finistère, Gironde, Hérault, Loire, Loire-Inférieure, Marne, Meurthe et Moselle, Morbihan, Nord, Oise, Pas-de-Calais, Rhone, Saone-et-Loire, Seine, Seine-et-Marne, Seine-et-Oise, Var, Vauchise, Haute Vienne, and Vosges. The largest increases, that is, those above 10,000 persons, are found in the following departments :—Bouches - du - Rhone (43,198), Finistère (12,636), Gironde (16,374), Meurthe et Moselle (22,267), Nord (75,527), Pas-de-Calais (31,885), Rhone (32,592), Seine (198,919), Seine-et-Oise (40,508), Var (20,855), and Vosges (11,216). In sixty-three departments there has been a falling off in the population, the greatest diminutions being found in the Orne, Manche, Dordogne, Lot, Haute Garonne, Yonne and Calvados. The number of foreigners in France shows a tendency to fall off, for while in 1886 there were 1,115,214 residing in the country, there were only 1,027,491 in 1896. This falling off is attributable not only to the effects of the law of the 26th June, 1889, but still more so to the law of the 8th August, 1893, on the protection of the national industry, which bore somewhat hardly, particularly in the matter of formalities, upon foreign residents. As regards Algeria, the total population in 1896, including the military, consisted of 4,429,421 persons, distributed as follows :—1,526,667 in Algiers, 1,028,248 in Oran, and 1,874,506 in Constantine.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

MAY 5.—"The Railway to India." By C. E. D. BLACK. SIR FRDERIC J. GOLDSMID, K.C.S.I., C.B., will preside.

MAY 12.—"Motor Traffic : Technical Considerations." By Sir DAVID SALOMONS, Bart. JOHN FLETCHER MOULTON, F.R.S., Q.C., will preside.

MAY 19.—"London Water Supply." By PERCY F. FRANKLAND, Ph.D., F.R.S.

MAY 26.—"Silver and Prices : the Economic drain of Debtor Nations." By MORETON FREWEN, B.A.

INDIAN SECTION.

MAY 6, at 4.30 p.m. — "Kafiristan : its Manners and Customs." By SIR GEORGE SCOTT ROBERTSON, K.C.S.I. (late British Agent at Chitral). FIELD-MARSHAL LORD ROBERTS, V.C., G.C.B., G.C.S.I., G.C.I.E., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday Afternoon, at 4.30 p.m. :—

MAY 4.—"The Arctic and Antarctic." By AUBYN TREVOR-BATTYE.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock :—

LEWIS FOREMAN DAY, "Design in Lettering."

Four Lectures.

MAY 3.—LECTURE I.—*The Alphabet.*—The Alphabet as we know it—How it came about—The development and growth of its letters, from the beginning to the time when the printing press more or less fixed their form—The changes through which the shapes of the letters successively passed—The mark left upon them by history—The accidental character of the letters of the Alphabet—What is essential in their form and what, for practical or artistic reasons, may be susceptible of modification and improvement.

MAY 10.—LECTURE II.—*Decorative Lettering.*—The Alphabet regarded more especially from the point of view of design—Its inherently decorative character—How far it was eventually affected, and to what degree shaped, by considerations of beauty—The art of the Calligrapher, his influence for good and evil—The relation of lettering to the implement, *i.e.*, the point, the chisel, the brush, the pen, &c., with which it is written—Penmanship *versus* printing—What decorative lettering should be, and what it should not be.

MAY 17.—LECTURE III.—*Ornamental Lettering.*—The Alphabet turned to deliberately ornamental purpose—How far that has been done, and how far successfully—Initial letters, as found in illuminated MSS., in early printed books, and in the books of to-day—The latitude allowed to the Artist in the design of initial letters and the like, and where he oversteps the bounds—Use before beauty—Ornament overdone—Legibility in lettering imperative—The exceptional cases in which the writer may mystify the reader—What we may do with the Alphabet.

MAY 24.—LECTURE IV.—*Lettering in Ornament.*—The place of lettering in the general scheme of decorative design—Its introduction inevitable—The universal use that was made of inscriptions, &c., in every form of decorative art, in all countries, and in all but recent times—The loss thereby to ornament—The masterly use of inscriptions in Gothic and other design—The most beautiful use of them in Oriental decoration—Sham Arabic inscriptions in Mediæval Art, a testimony to the decorative quality of mere lettering—Further possibilities of ornament in our own Alphabet—The value of Lettering in ornament, the opportunity for it, the scope in it.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 3...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Lewis Foreman Day, "Design in Lettering." (Lecture I.—The Alphabet.)

Royal Institution, Albemarle-street, W., 5 p.m General Monthly Meeting.

Engineers, in the Theatre of the United Servic Institution, Whitehall, S.W., 7½ p.m. Mr. Henr O'Connor, "Automatic Gas Station Governors.'

National Indian Association, Imperial Institute South Kensington, S.W., 4½ p.m. Mr. Justic Jardine, "Present Thought and Sentiment i India."

British Architects, 9, Conduit-street, W., 8 p.m Annual Meeting.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m Paper on "Nippur : its inscriptions."

TUESDAY, MAY 4...SOCIETY OF ARTS, John-stree Adelphi, W.C., 4½ p.m. (Foreign and Coloni Section.) Mr. Aubyn Trevor Battye, "The Arct and Antarctic."

Royal Institution, Albemarle-street, W., 3 p.n Dr. Tempest Anderson, "Volcanoes." (Lectu II.)

Central Chamber of Agriculture (at the HOUSE c THE SOCIETY OF ARTS), 11 a.m.

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 37, Great Russell-street, W.C 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. M J. E. S. Moore, "The General Zoological Resul of the Tanganyika Expedition of 1895-96." 2. M Walter E. Collinge, "Some European Slugs of tl Genus *Arion*." 3. Mr. Frederick J. Jackso "Field-Notes on the Antelopes of the Mau Di trict, British East Africa. With Notes by Mr. L. Sclater."

WEDNESDAY, MAY 5 ...SOCIETY OF ARTS, John-stree Adelphi, W.C., 8 p.m. Mr. C. E. D. Blac "The Railway to India."

Archæological Association, 32, Sackville-street, W 4½ p.m. Annual Meeting.

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, MAY 6...SOCIETY OF ARTS, John-stre Adelphi, W.C., 4½ p.m. (Indian Section.) S George Scott Robertson, "Kafiristan : its Manne and Customs."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m.

Chemical, Burlington-house, W., 8 p.m. 1. M A. E. Munby, "A Bunsen Burner for Acetylene 2. Messrs. H. C. Jenkins and E. A. Smith, "T Reactions between Lead and the Oxides Sulphur."

Society for the Encouragement of Fine Arts, 8 p. Conversazione at the Galleries of the Ro Society of British Artists, Suffolk-street, S.W.

Royal Institution, Albemarle-street, W., 3 p. Professor Dewar, "Liquid Air as an Agent Research." (Lecture II.)

FRIDAY, MAY 7...Camera Club (at the HOUSE of the SOCIE OF ARTS), 8 p.m. Lantern Slide Exhibition.

United Service Institution, Whitehall, S.W., 3 p.m

Royal Institution, Albemarle-street, W., 8 p. Weekly Meeting. 9 p.m. Mr. Anthony Hop "Romance."

Geologists' Association, University College, W.C 8 p.m. Mr. W. W. Watts, "Coral Islands."

Philological, University College, W.C., 8 p. Annual Meeting.

Quekett Microscopical Club, 20, Hanover-squar W.C., 8 p.m.

SATURDAY, MAY 8...Botanic, Inner Circle, Regent's-par N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Re J. P. Mahaffy, "The Greek Theatre according Recent Discoveries." (Lecture II.)

Journal of the Society of Arts.

No. 2,320. Vol. XLV.

FRIDAY, MAY 7, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *Conversazione* will be held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 16th June.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. In addition to this, each Member will be able to purchase additional tickets, the price of which will be 5s. each up to the day of the *Conversazione*; on that day the price will be raised to 7s. 6d. It is requested that Members requiring these additional tickets will make early application for them. Every application must be accompanied by a remittance.

Further particulars as to the musical and ther arrangements will be published in the *Journal* later on.

CANTOR LECTURES.

On Monday evening, 3rd inst., Mr. LEWIS . DAY delivered the first lecture of his course n "Design in Lettering."

The lectures will be published in the *ournal* during the summer recess.

OREIGN & COLONIAL SECTION.

Tuesday Afternoon, May 4, 1897; Major . E. W. MALET in the chair.

The paper read was on "The Arctic and ntarctic." By Aubyn Trevor-Battye.

The paper, with the report of the discusion, will be printed in a future number of the *ournal.*

NTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The fourth meeting of the Congrès International de l'Enseignement Technique will be eld this year in London, commencing on the 15th of June next, at the invitation of the Society of Arts, and of the Worshipful Companies of Drapers, Fishmongers, Goldsmiths, Merchant Taylors, and Clothworkers.

Further information respecting the Congress can be had on application to the Secretary, Society of Arts, John-street, Adelphi, London, W.C.

Proceedings of the Society.

NINETEENTH ORDINARY MEETING.

Wednesday, May 5, 1897; Major-General Sir FREDERIC J. GOLDSMID, K.C.S.I., C.B., in the chair.

The following candidates were proposed for election as members of the Society:—

Bird, William Frederick, Midsomer-Norton, Somerset.
Fox, Edwin, 99, Gresham-street, E.C.
Harvey, E. Field, Omrac, St. John's, Newfoundland.
Moss, Charles Herbert, Thorn Bank, Rotherham.
Reeves, Hon. Sir W. Conrad, The Eyrie, Barbados, West Indies.
Skaife, Wilfrid T., 630, Sherbrooke-street, Montreal, Canada.

The following candidates were balloted for and duly elected members of the Society:—

Calthrop, Everard R., The Barsi Light Railway Company, 56, Naylor-street, Liverpool.
Griffith, F. B., Barbados, West Indies,

The paper read was—

THE RAILWAY TO INDIA.

BY C. E. D. BLACK.

Railway comunication between a mother country and a colony is an obvious desideratum where practicable, but the case of England and India is so exceptional that the wonder is, how it has come to pass, ever since the development of railways, that nothing has been done to carry out the idea. The salient features of the position are easily recognisable. Between the two countries there is a never-ceasing stream of officials, soldiers, sailors, merchants, and miscellaneous travellers, to say nothing of wives, children, and servants, which, though it flows more copiously during the cold season, never dries up, and is a striking criterion of the enormous bulk and the supreme importance of the commercial and administrative intercourse between our Eastern

Empire and the home country. There is nothing, I venture to say, in the whole world, to rival the case of a vast empire like India, with its 270,000,000 of inhabitants, which is garrisoned and governed from an administrative base 6,000 miles away. To shorten communications between the two countries is evidently of the highest importance, especially in the case of war, mutiny, or any great or sudden emergency. But as Europe, Asia, and Africa lie across our direct road to the East, it behoves us to consider carefully how to select a route which shall be, as far as possible, secure from molestation or interruption at the hands of others, and which shall lie within our own sphere of influence and control.

I am afraid this important condition at once rules out the idea of a grand trunk line, which shall begin at Calais and, passing through Constantinople and Asia Minor, emerge at Candahar or Peshawar. Not that I mean to deny the possibility or advantage of such a line; for improved railways mean enlarged intercourse and the strengthening of peaceful bonds between nations. But no such trunk line, traversing the actual arena of international jealousies and complications, and passing through the very focus of the Eastern question, would fulfil the idea of a *British* Imperial line, designed to bridge over the physical gulf between Great Britain and her possessions in the East. Fortunately, so long as we have possession of the Mediterranean, the necessity for quicker transit over the western or European half of the route to the East does not press so much. It is difficult to conceive of any possible political combination which would deprive us, all at once, of Marseilles, Brindisi, and Salonika as entrepots in time of peace, or of the Mediterranean itself in time of war. The Cape route is, of course, available in the last resort, but I assume that we shall always cleave to the Mediterranean route, come what may, and our tenure of Gibraltar, Malta, Cyprus, and Cairo, are, I take it, very substantial and solid guarantees of this national determination. It is when we reach Egypt, the halfway house, that the question suggests itself, now that we have emerged from the nervous and energetic sphere of busy European rivalry into the calmer atmosphere of Oriental repose, cannot we choose a shorter cut than the long, roundabout Red Sea and Indian Ocean route? Look at the map and you will see what a huge obstruction is presented by the enormous peninsula of Arabia, which juts out southward for over two thousand miles, causing a wearisome detour of from three to four days down the Red Sea, while the further transit across the Arabian Sea to India is of equal and sometimes longer duration. A straight line drawn, as the crow flies, from the northern end of the Suez Canal to Kurrachee, or whatever we may pitch upon as the western land gate of India, coincides with the route which I venture to say is the shortest and best line for a railway to India. It may be urged against me that I myself have not explored this route, and so am hardly qualified to speak of it; but in this respect I am in the same boa as everybody else. No one, so far as I am aware, has ever traversed the whole of the route, though different travellers have covered various sections of it. During a pretty long service in the Geographical Department of th India-office, I had the opportunity of perusing a vast amount of literature, published an official, on the geography of these countries and on various projected railways to the East It was only after a lengthy process of stud and elimination that I arrived at the con clusion that the present scheme was the bes and most deserving of exhaustive examination

The route would be from Port Said eas ward across the peninsula of Sinai to the Gu of El Akabah, and thence, following the 30t parallel of latitude, to Bussorah. A branc would deviate a little to the south to the po of Grane or Koweit, which, it may be remen bered, was the terminus of the Euphrat valley line, on which a select committee of th House of Commons sat 25 years ago. Fro Bussorah the main line would cross the Sha el-Arab and Karun rivers by swing-bridge and follow the coast line of the Persian Gu and Makran to Kurrachee.

Such are the main features of a line th possesses advantages that pertain to no oth project. First and foremost, it passes throug what may be truly called the British sphere influence. The easternmost part, where closes on to the Indian railway systems, li through or along the coast of Baluchistan, province that is now part of British Ind while the westernmost section, from Port Sa to the Arabian highlands, cuts through province of Egypt, which is similarly und our dominion. The Arabian and Persi sections alone traverse regions not under actual rule, but of which it may be said th our influence there is greater than that of a other suzerain power. The Arabian secti

raverses independent territory acknowledging
o sway but that of the Amir of Jebel Shomer,
he autocrat of Central Arabia; while the
ersian section passes through the southern
art of that huge kingdom, where British in-
luence is as strongly predominant as Russian
nfluence may be said to be in the north.
here remain one or perhaps two narrow strips
f territory south-west of Bussorah, and east of
kabah, where a nominal jurisdiction is exer-
ised by the Sultan, but I am satisfied, from
nquiries that I have made, that this would
rove no obstacle to any scheme for a through
ailway.

Such being the political aspect of the ques-
ion, I ask myself, what are the physical
bstructions to such a line? From Port Said
o Bussorah much of the country is sterile,
ut it is rather stony than sandy, as the name
f Arabia Petræa clearly indicates. The
efud or shifting red sand desert lies south of
he route I propose. Not only that, but there
s a very remarkable and fertile depression
etween the Gulf of Akabah and the head of
he Persian Gulf, which is as suitable for a
ine of railway as if Nature had actually
noulded it for that express purpose. This
lepression has been explored by various
ravellers, foremost among which are Guar-
nani, Palgrave, Huber, Doughty, and Mr.
Vilfrid and Lady Anne Blunt. It extends
rom the Wady el Sirhan eastward through
l Jûf and other towns inhabited by many
housands of Arabs, into a fertile valley which
tretches close up to a tributary of the Shat-el-
rab. The only unexplored part is a stretch
f about 200 miles between El Jûf and the
oint where the pilgrim route between Yemen
nd Bagdad passes north and south. But
here is ample evidence that the nature of the
nexplored strip cannot be very different from
hat of the surrounding tracts. Indeed, the
eneral tendency of the geographical data is
o convince me that the line I venture to draw
ttention to, lies along the course of an ancient
iver bed, which, roughly speaking coincides
ith the trend of the 30th parallel of north
titude. Nothing could be more suitable
om the point of view of physical geography,
r there are neither mountains or rivers to
ross until we reach the Shat-el-Arab. Here
e greatest difficulties of the line arise, for
ere are two rivers, and an alluvial stretch of
ountry subject to occasional inundation to
averse, until we have rounded the head of the
ersian Gulf, and entered upon the strip of
w land that fringes its eastern coast from Bushire to Bunder Abbas. The peculiar suitability of this tract of country for a railway was pointed out 25 years ago by Mr. Palgrave, brother of the present clerk of the House of Commons, and was corroborated a few years ago by Mr. Treacher Collins, in his voyage up the Gulf. Mr. Palgrave's words are :—

> "I have landed at every little port or possible place along the whole length of that coast from Jask up to Bushire; it is thinly peopled, but by no means desolate or destitute of inhabitants, and it is well supplied with water, and the mountains which line it, although not far from the sea, yet in hardly any case come down actually upon the sea, but have a plain of various breadths, sometimes as much as twenty miles, sometimes less, which plain, as I say, is perfectly well inhabited, and is well supplied with everything necessary to life that is as far as Jask, but the coast of Baluchistan, further on from Jask and Kurrachee, I do not know."

But Mr. Palgrave's want of knowledge with this region is of no consequence in these days, because the course of events has been to incorporate Baluchistan into the British Empire. Colonel Holdich, probably the most distinguished and experienced of Indian topographers, writes to me :—

> "All probable railway routes through Makran have been examined in the course of surveying, many of them approximately levelled. So far as I know, there is no great engineering difficulty in the route you propose, except in rounding the Malán range in Makran. There would also be some big bridging in Persia, but there is nothing insuperably difficult."

Such are the general conditions of the line which, as I suggest, should connect Port Said with Kurrachee. Its advantages I would briefly sum up as follows :—

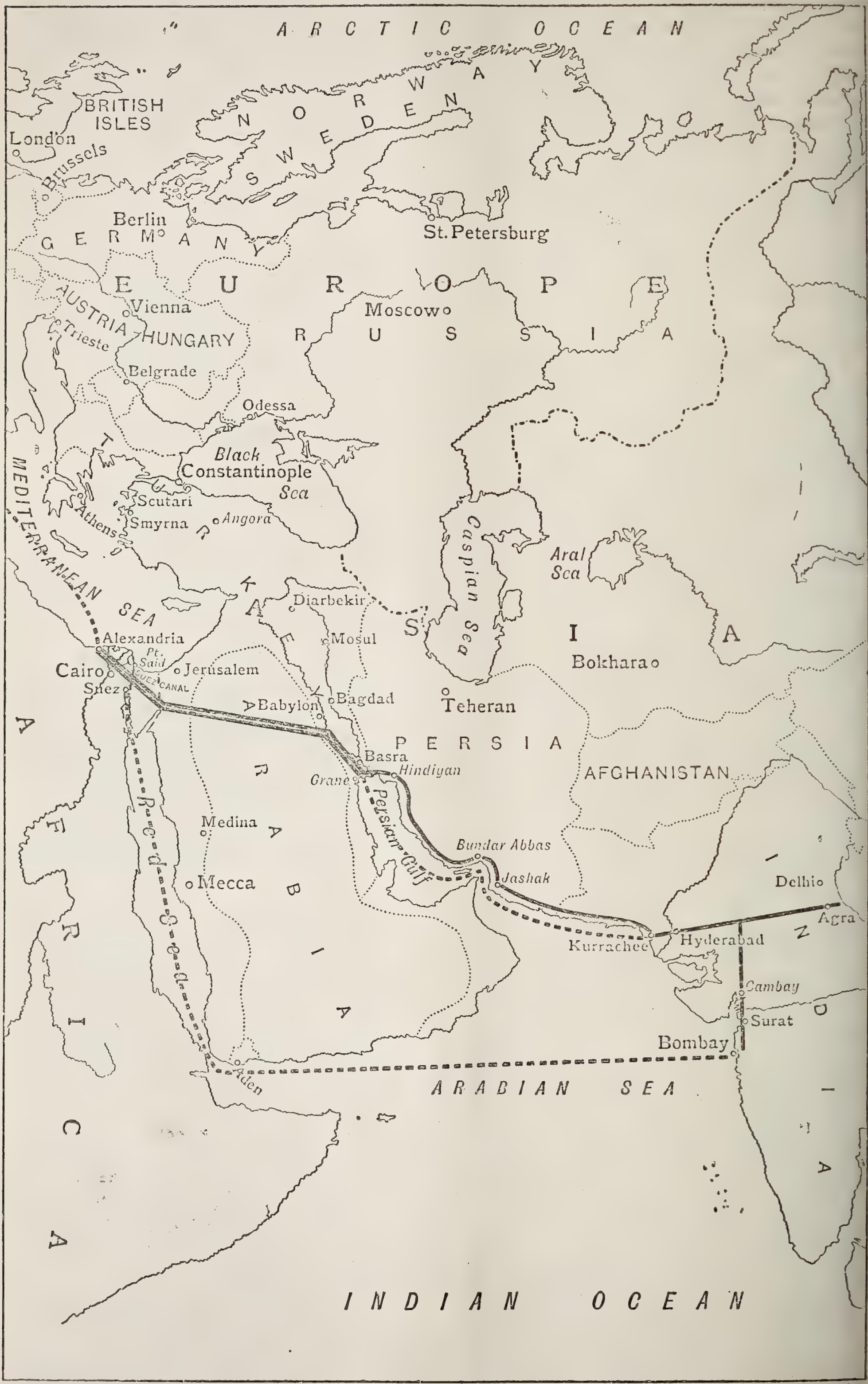
It would reduce the time occupied in transit between London and Kurrachee to eight days.

It would run through regions where British influence is predominant, and these would avoid all the political complications attaching to lines passing through Asia Minor, Armenia, Northern Persia, and what may be called the Russian sphere of influence.

The Persian and Baluch sections could be constructed along the coast, and, in case of war, defended by the guns of our fleet. The Arabian section is defended by nature from aggression, as it is bounded by the Syrian desert to the north, and the Nefud or Red Sand desert to the south.

It would form a grand trunk line for mails, passengers, and troops, who could be conveyed to India in half the present time.

There is one important additional argument



Walker & Boutall sc.

PROPOSED LINE OF RAILWAY BETWEEN THE MEDITERRANEAN AND INDIA on which I have not yet touched. It has been pointed out to me by a well-known officer of the Indian Army, who has taken the greatest interest in this project, and whose absence in India at the present I much regret, that a great advantage of this railway would be the possibility of establishing a depôt for the Indian troop relief at a suitable and fairly elevated station near the northern end of the Suez Canal, between Port Said and the Syrian frontier. These reliefs amount to about 12,000 men each way yearly, and if a garrison were there installed, the troops in barracks at Cairo and Alexandria might safely be withdrawn, and those places left under the Khedive's army officered by British and Egyptian officers as it is now. Such a new Mediterranean station would complete the chain of Gibraltar, Malta, and Egypt, a chain which at present is very shaky, so far as the Egyptian end is concerned, and liable to be entirely interrupted if the Suez Canal were blocked.

I look upon this feature of the project as one of the highest importance. It would, in the first place, be a visible embodiment on the shores of the Mediterranean of the English tenure of India. At present, the reliefs on the way out are only seen for a few hours as they pass through the canal, and the moral effect produced by a permanent garrison at that station would be undeniably strong. The Continental Powers must admit that we are bound to have this direct access to our Indian Empire, just for the same reason that the trans-Caspian and trans-Siberian Railways have been found to be necessary to Russia.

The facility with which the Suez Canal may be blocked is notorious. In February last year one of the North German Lloyd mail steamers for Australia grounded in the Canal, and in very little time 65 vessels were blocked, and unable to get on. If this stoppage were deliberately planned, nothing would be easier than for a Power having unfriendly intentions to arrange for three steamers at intervals to turn their heads sharp into the bank, or for craft to be sunk, and the obstruction might take weeks to remove. As it is large steamers have to exercise great care in going through. I should hardly have thought it necessary to dwell on this danger had it not been that in discussing the matter with a very distinguished military authority, he expressed the opinion that in case of war England ought to *prevent* the Suez Canal from being blocked by excluding any vessel having sinister objects. I confess I don't see how one can detect a vessel's intentions from her appearance, for a pound of dynamite might be hidden under a very innocent exterior. In fact, it could be done without dynamite at all. I was reassured, however, on finding the danger I refer to is officially recognised, for in a recent Blue-book on Indian finance, one of the witnesses, Sir E. Collen, at question 6,549, distinctly admits that in case of stoppage of the Canal the alternative route to India would have to be round the Cape.

As a "second string" to our bow, the proposed railway would be invaluable. The shortening of communication scarcely needs dwelling upon. But it is important to observe that the saving of time is effected more by the trans-Arabian section than by the other more easternly sections of the line. In fact, the trans-Arabian section may be called the key of the situation, and if that part of the chain be constructed first, the remaining links may easily wait, for they will naturally fall into their place at the most convenient time, and the delay in completing them would not materially lengthen the journey. In other words, I think the railway need not be constructed all at once. It would be sufficient, for the present, if the line from Port Said to Bussorah, with a branch to Koweit were taken in hand. The distance is roughly 1,000 miles, and with the exception of the above-mentioned tract, about 200 miles in length, east of El Jûf, the topography is known to be perfectly easy. Mr. Charles M. Doughty, the well-known explorer of these parts, wrote to me not very long ago as follows :—

> "A railway to India, making us less dependent on the Suez Canal, is truly a patriotic enterprise, which by way of Northern Arabia I have often thought upon, and which, I believe, if money could be found for a political investment, to be quite feasible. . . . . . The entry mastered, the rest is a high plateau without serious difficulty, and everywhere there is water enough within reasonable distance."

This is the opinion of one of the few persons actually acquainted with the physical conditions of Northern Arabia, and ought therefore to command attention. With regard to the general characteristics of the country, Colonel A. T. Fraser, R.E., who has traversed Mesopotamia and taken special care to collect all the information he could regarding this project, writes to me thus :—

> "The only engineering difficulty is the crossing of the valley of Akabah, and rising 1,400 feet to the plateau of Central Arabia, which railways do on the Western Ghâts of India every day. I have no misgivings as to the country passed through, water

supply, climate (which is much healthier than India), or traffic—local or direct—or trouble with Arabs."

As to the latter, I may remark that the evidence laid before the Euphrates Valley Committee is conclusive. Captain Felix Jones, than whom there was no greater authority, remarks:—

> "I know from my own experience how easily the Arabs in the Euphrates and Tigris valleys are conciliated, though they offer obstacles in your way at the outset, but with tact and temper and fair dealing, as I have said before, I am quite aware that the Arabs can be rendered as peaceful as so many children."

A subsidy would of course be necessary to the Bedouin Amir of Jebel Shomer for leave to carry the line through his country, and I gather from Mr. Wilfrid Blunt and Mr. Doughty, who have both seen him, that the Amir might probably be willing to fall in with this arrangement. Smaller local allowances might also be required for the chiefs of the principal tribes, who would by this means be made responsible for the good behaviour of the tribesmen, not only while the railway was under construction but after it was opened for traffic. I believe the plan of making allowances in this way to the Arab tribes, in the case of the telegraph line to Palestine, answers very well. The native Bedouins themselves are poor, owing mainly to the scarcity of provisions and the high cost of carriage. I have no doubt whatever that they would volunteer as gladly as they did for the Suez Canal, in the construction of the railway, and both from this and from the subsequent allowances they would benefit so materially that a friendly feeling would spring up between them and the English.

I have not yet touched on the commercial advantages of the project, but I have every reason to anticipate that they would be considerable. Of course I know that estimates of goods traffic are as a rule little more than a rough speculation. Sir Henry Tyler, a great authority, remarked as follows to the Euphrates Valley Committee:—

> "Calculations as to traffic are worth very little even in a settled country in England when you project a line; it is a mere guess. In almost every instance which I have ever heard of the traffic has exceeded the calculations which have been made before the line has been opened."

Nevertheless we may confidently assume that the traffic on this line would be very great. As I remarked in an article I wrote in the *Contemporary Review* two years ago, no one who has followed the development of our Eastern Empire during the last quarter of a century can have failed to notice the expansion of ideas that is thus taking place and the increasing tendency to bridge the gaps that separate India from her neighbours. It is little more than a decade since Upper Burma was annexed, and already surveys are being made and schemes formulated for uniting the railway systems of Bengal and Burma, while the prolongation of such lines down the Malay peninsula to Singapore is talked of. Not only this, but it is in contemplation to carry out some missing links in the railway system of India proper, which will have the effect of shortening communication between Kurrachee and Calcutta by 487 miles, a clear proof of the advantages which are now seen to accrue from bringing Kurrachee into closer touch than heretofore with the rest of India. Were the Indo-Egyptian railway from Kurrachee to Port Said once begun, I feel sure that a direct trans-Indian line, with a continuation down to Singapore, would not lag far behind, and in that case we should have an uninterrupted line from the Mediterranean to Singapore, a railway which would doubtless command the most extensive through traffic, both for passengers and goods, in the world. Not only would it convey passengers to Arabia, Mesopotamia, Persia and India, but all bound for the Eastern Archipelago, Indo-China, including Siam and Tonkin, Hong-Kong, China, Japan, Australia, and New Zealand, ought to travel by it; while the goods traffic would be simply gigantic. The number of first-class passengers alone I estimate at 20,000, who would be only too glad to pay even the same as they do at present between Port Said and Bombay, provided they could save in their whole journey from one to two weeks in time, according to their destination. This item would mean about £400,000 per annum. As for goods, it is extremely difficult to forecast exactly; but I think, considering the important part that the line must play in respect of the conveyance of the mails, troops, and the trade of the East generally, it is a very moderate assumption to say that such a railway would earn as much as the mean traffic returns of the Indian railways, which, in 1896, worked out to Rs. 246 per mean mile per week. There would be an enormous pilgrim traffic to the holy places of Arabia, while along the shores of the Persian Gulf it was the opinion of Mr. Palgrave that there would be considerable trade as soon as ever communications with the towns on the interior plateau were improved. This is also the opinion of Colonel Fraser, who writes to me in still stronger terms regarding the productiveness of Mesopotamia and Turkish Arabia, where, in his words, "a gold standard is maintained and produce sells at a gold price, which the bulk of Indian, China, and Japan products does not." Through Northern Arabia it is the opinion of the same authority that there would be a good trade as soon as time was given it to develop; and the occurrence of several towns along the valley I speak of, seems to justify this. El Jûf alone has from 10,000 to 12,000 inhabitants, extensive gardens and date palm groves, and supplies are plentiful; while there are other towns further east.

The total length of this line from Port Said to Kurrachee is estimated at 2,400 miles, and it is proposed to construct it in the Indian broad gauge, so as to admit of through trains, by which means the entire distance between London and Kurrachee would be covered in seven days. From an engineering point of view, I am assured that the line could be constructed in three years. The cost, considering the flat and comparatively easy nature of the ground, the absence of high mountain ranges, and paucity of rivers, and the facility of constructing it from the sea for a large portion of its length, ought not to exceed £5,000 per mile—£12,000,000 for the entire length, or, with rolling stock, £15,000,000. Assuming that such a railway would earn at least as much as the mean traffic returns of the Indian railways, this would work out at Rs. 3,07,00,803 —or say £2,000,000, considering that a good proportion of these receipts will be paid in gold—per annum, in addition to which would accrue the telegraph receipts which, for the section from Egypt to the Persian Gulf, would be subjected to no competition. Estimating these at £100,000—a very modest reckoning—we get a gross total of £2,100,000. Deducting 40 per cent. for working expenses, which for a through railway of this description should be ample, we should have—

Gross earnings	£2,100,000
Working expenses	840,000
	£1,260,000

The balance would be available to meet the interest on the capital advanced, which I have no doubt would be freely subscribed by the public if the Government after full inquiry were satisfied that the construction of the line was a national necessity.

I have assumed throughout that the line would eventually be constructed in its entirety along the route I have indicated. But I am convinced that, to begin with, we may conveniently restrict ourselves, as I remarked above, to the construction of the portion of the line from Port Said to the Persian Gulf, leaving the Peninsular and Oriental Steam Navigation Company to convey their passengers from Brindisi to Port Said as now, and also encouraging them to organise a fresh and rapid service from the head of the Persian Gulf to Kurrachee. This would not interfere, of course, with the slow but profitable coasting service of the British India Company up and down the Persian Gulf. All heavy goods would probably still go through the Canal; but until the Persian and Baluch portions of the line were completed, it might suit the Peninsular and Oriental Company to convey the mails from Koweit to Kurrachee. There would, of course, be extra transhipment involved thereby, but the saving of time would be considerable, while, as regards commerce, it is a truism that improved facilities of communication create trade. There would be no valid ground for the Peninsular and Oriental Company to anticipate any serious diminution in their returns; as is well known in cases of this sort, matters adjust themselves without any sudden dislocation or disorganisation, and the expansion of trade and the general convenience of the public, are benefits in which all parties share. I anticipate an important object-lesson of this nature in regard to the Suez Canal Company; they may possibly dread a falling off in their returns, if our line is to divert part of their traffic and convey passengers and some classes of goods to the East, but, *per contra*, the railway will confer a great benefit on that company, for it will lead to an enormous expansion of business at Port Said, the harbour dues of which belong to the canal company, and it will thus help to carry out their longed for dream of developing that port, which hitherto they have been unable to achieve owing to the rivalry and jealousy of Alexandria.

In conclusion, I should like to say this much. I have discussed this subject with very many persons—a hundred or so—nearly all of whom are well qualified to give an authoritative opinion on its merits and drawbacks. The great majority of these are entirely favourable thereto, and pronounce it to be an enterprise well worthy of national support. The minority, of whom I desire to speak with all respect, have found more or less fault with the idea. But I may conscientiously say that in no case have I experienced the slightest difficulty in answering any of their objections. Whether I have done so successfully or not is, of course, a matter of opinion. But whether or no, this is not what is required. Mere opinions can be obtained very cheaply. What is really wanted is some systematic inquiry, examination, and careful consideration of the scheme, both in its general scope and component details. Under the vastly increased public interest that now-a-days attaches to all public questions, great and small, it is extremely difficult to attract the serious notice of Government to any great undertaking unless it commends itself in the first instance to popular approval.

A quarter of a century ago things were different, and a project which aimed at establishing a railway through Turkish territory from Northern Syria and down the Euphrates Valley to the Persian Gulf, was readily subjected to examination at the hands of a Select Committee of the House of Commons. It was not a railway to India, but simply in the direction of India, and the greatest saving of time it hoped to effect in the eastward transit was two or three days. It was also hampered by the serious political inconvenience of being wholly confined to territory under the jurisdiction of the Sultan. The project which I venture to submit to you is more comprehensive and, as I am convinced, far more practicable. It traverses ground which our greatly enhanced influence in Egypt, Southern Persia, and Baluchistan justifies us in styling ground within the British sphere of influence; it connects India and Egypt, and thus tends to the advantage of both these countries. Again, it effects a most important shortening of time in the transit between the two countries, a saving of more than 50 per cent., and I am fully persuaded it will thereby offer a great encouragement to the flow of capital to India from this country, for it will enable capitalists to visit the East with far greater facility, and personally see to their investments, while English interest in Hindostan will be powerfully stimulated. It will thus subserve the general trend of India's development and the great and growing desire for the consolidation of our Empire. All I ask you is to agree with me in the contention that a *primâ facie* case has been made out for detailed official examination, and I have no fear for the result. I can conceive of few nobler enterprises in this happy year of a happy reign.

DISCUSSION.

The CHAIRMAN said he had been over the greater part of the country referred to, having travelled from Kurrachee to the Caspian overland, and had also been backwards and forwards through Persia in all directions. He should be sorry to say anything which might seem to be throwing cold water on the scheme now put forward, but he felt bound to say that he did not think a railway along the coast line at the south of Persia was much more free from political complications, if at all, than one running direct through Persia. In the latter case the Persian Government would no doubt have an interest in it, and in its protection, because it would enable them to traffic with other countries; but a line along the coast would practically be of no use to the Persian Government unless subsidiary lines were made in connection with it. Baloochistan had been referred to as being under the ægis of British protection, and that was so to a great extent, but the western side belonged to the Persian Government, and Great Britain had no more control over it than over Persia itself. What really commended this scheme was the direct line from Alexandria across to the head of the Persian Gulf; this, if they could arrange with the Arabs of the desert, would be free from political complications, but he was not quite certain that the Sultan at Constantinople would consider that this was outside his jurisdiction. He laid claim to the holy places of Mecca and Medina, and probably he might claim that part of Arabia through which the line would run. At any rate, he (the Chairman) would not be surprised if difficulties arose in that direction. Otherwise he thought there was a good deal to commend this line, and as to its being an immense advantage to Great Britain and British India, there was no need for argument. A line of this description through a rich country like Mesopotamia would be very usefu to India in years of famine. With regard to the distances and the exact line to be used those were minor points to be considered afterwards. The great question was to take the map and see where the line should run and through what countries. If they could only come to some conclusion on that point it would be a great thing, but he could not forget that evidence was taken a great many years ago about the Euphrates Valley Railway and nothing had come of it. He made these remarks because he knew the country, and years ago reported on Makran, and drew the line of demarcation.

Mr. J. W. PARRY said, the first point that struck a practical man was that no survey had been made along the proposed alignment, and so of course there were no reliable data to base any conclusions upon, He did not know that even a barometric reconnaissance had been made over any portion of it. Mr. Black said that the only unexplored part was a stretch of about 200 miles, but that there was ample evidence that the nature of that strip could not be very lifferent from that of the surrounding tracts. He should have been grateful for some of this ample evidence, for it was not so evidently obvious, nor was 200 miles a strip of country to be despised. Those who iad done survey work knew that judging a country rom maps was often deceptive; some portions were easier than they looked, while others were more difficult. The crux of the whole matter, however, was the cost, which Mr. Black said ought not to exceed £5,000 per mile. The total length he gave at 2,400 miles, vhich he was assured could be constructed in three ears. He should like to know who assured him hat a line 2,400 miles long could be constructed in hree years, and if he had the assurance in writing. Could he name a railway 1,200 miles in length which iad been completed in that time? From his xperience he could assure Mr. Black that the ompany or contractors who could build—in a olitically safe country—2,400 miles in five or six ears, would not only deserve their profits, but all he honours which a grateful country could bestow ipon them. Mr. Black might consider that his line hould cost about the same as the standard gauge ndian lines. Now, the East Indian, Eastern Bengal, Great India Peninsula, and Bombay, Baroda nd Central Indian, each cost over two lakhs per mile in the days when the rupee was not lepreciated, or over £20,000 per mile; while he average of ten standard gauge lines worked ut to Rs. 164,440, which, converted at 1s. 3d. per upee, gave £10,410 per mile. Had Mr. Black onsidered that officers and men would require at east double Indian pay for working in these inospitable regions, the police escorts that would be ecessary for each member of the staff, the requirenents of food supplies, water, shelter, sanitation, nd hospital accommodation for this army of coolies, nd had he pondered over the rates that would be emanded by contractors for risking their lives, and ne delays that would occur upon acquiring land and ollecting labour? Colonel Fraser's scheme was nore feasible than Mr. Black's, as he proposed to mit the line to the port of Basra for the present, ut even then 1,000 miles had to be constructed, nostly through the Arabian desert. Mr. Black and Colonel Fraser deserved their best thanks for drawing ttention to this route, and for the trouble they had aken in the matter. As the treasury of the Egyptian Government was particularly full after the annexaon of Dongola, and as there were several Royal Engineers in that service, perhaps the authorities night be induced to advance the necessary funds or the detailed official examination of this route, hich they all so much desired.

r. MARTIN WOOD said it was very appropriate that Sir Frederic Goldsmid should occupy the chair that evening, as he knew all about the countries concerned, and also the various projects which had been brought forward from time to time for a railway to India. He had spoken rather tenderly of the present proposal, and so far as political considerations were involved there might be some advantage in this new route, though there was a good deal of exaggeration about the political difficulties, which could easily be overcome if a thoroughly good scheme were put forward. The last time this subject came before the Society was in 1882 or 1883, when an abstract of a paper by Mr. Fell was published, in which a route from Alexandra to Bussorah was proposed; this was to cost 8½ millions. That was one of the projects of Sir W. Patrick Andrew,* a very sanguine gentleman, who made calculations to show that there would be a profit of £407,000, or 5½ per cent. on the capital. He understood that the chief object of civil engineering was to remove friction, and it appeared to him there was no comparison between the amount of friction involved in dragging produce for thousands of miles through a tropical region, and that involved in water carriage, for the sea was the great highway of which no power could deprive us. Much had been said of the Suez Canal being blocked, which of course was a possibility; but the obvious alternative in such a case was the Cape route, which in these days of improved steamers was by no means to be despised. But there was also another alternative, viz., another canal from the Levant into the Red Sea, and in his opinion such a canal would be incomparably more productive and more economical than any railway which could be devised through those regions. He thought the estimated cost of £5,000 a mile was quite out of the question. No doubt the Indian lines referred to by the last speaker were constructed a good while ago, and on very extravagant terms, but still the cost of construction of such a line must be formidable, and also the working expenses. The whole of the fuel would have to be carried from the Levant, and a supply of water would have to be provided for; in fact, there seemed to be every impediment in the way of the railway being successful. Nor did he see the immense advantage which would accrue. An exaggerated importance was attached to the question of time, and he did not think the period named, eight days, had been satisfactorily made out. It would not be possible to raise £15,000,000 without a guarantee, and who was to give it? India certainly could not, in her present financial position. The plan was very attractive and interesting, but he feared it was not at all practical.

Mr. TREACHER COLLINS said he was suddenly summoned to Persia in 1894, and he had to approach it by way of the Persian Gulf. His attention was naturally directed to the proposed railway across the Arabian desert, and on his journey he stopped at every port and took the opportunity of examining the country as far as he could and ascertaining the lie of the land. He had seen it stated that there would be great engineering difficulties in constructing a railway along that coast land, because the high table land of Teheran extended right down to the seashore, but that was not the case; there was a stretch of land seven miles in breadth all along the seashore which seemed specially designed for a line of railway. He never appreciated the truth of the saying, "Britannia rules the waves" so much as in his passage up the Persian Gulf. There was an extensive sea on the borders of which Britain had not an inch of territory, and yet her influence was everywhere predominant. She put down piracy and settled the feuds between the petty potentates in the neighbourhood. As long as she preserved that supremacy such a line of railway would be conducive to British interests. He thought the Persians would rather approve of this railway, and all the more so because it did not open up their country, as they preferred to be left to themselves. No doubt the heat was a trouble in some parts, but not all the year round; in March it was not at all excessive, and travellers would, of course, choose a favourable time, just as they avoided the monsoons in the Indian ocean when possible. Reference had been made to the pilgrim traffic to Mecca and Medina, but there was also a great traffic to Kerbela, where there was a sacred shrine. If this railway were made, he believed it would open up southern Persia to English commerce, and stimulate industry there.

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* This probably refers to Sir William Andrew's paper on "Euphrates Valley Route to India," which was published in the *Journal*, vol. xxviii., p. 257.

Mr. BLACK, in reply, thanked the Chairman for his suggestions. The criticisms which had been made were rather on points of detail than of principle. If no attempt was made to infringe too far on Persian territory, he thought probably the Government would not object to the scheme. Of course the good feeling of the local people was not the same thing as the consent of the authorities at Teheran, but it would probably have some influence. The Chairman had referred to Western Baloochistan being under Persian influence, but within the last year a line of demarcation had been made by Colonel Holdich between the Balooch territory and the Persian; and as far as he could understand, Baloochistan was within the British sphere of influence. He quite admitted that the Arabian portion of the line might be objected to by the Sultan of Turkey, but that objection could only be dealt with when they knew what the Sultan had to say to the scheme. He had been assured, however, that his jurisdiction over that district was very shadowy, and was more of a religious than of a political character. Mr. Parry said there had been no surveys made, but he did not think surveys were necessary in order to form a *prima facie* opinion as to the portion of the line on the sea shore. With regard to the portion traversing northern Arabia, it had been visited by a French traveller, Huber, now deceased, whose maps contained a large number of altitudes, and from them there would be no difficulty in forming a very fair section of that portion of the line. With regard to the remainder of Mr. Parry's criticisms, he must admit that he was not an engineer, and was, therefore, hardly qualified to deal with them; he could only consult such friends as he had, and on the information thus supplied he had based his remarks. He was quite aware that many Indian railways cost much more than £5,000 a mile, but he might quote from the evidence of Sir Donald Macleod before the Euphrates Valley Committee, to the effect that there was no reason why a line should not be made between Aleppo and Koweit for from £5,000 to £6,000 a mile. Of course, there was a difference between the smaller gauge there referred to and the broad gauge he proposed, but he did not think in this case that would amount to much.

Mr. PARRY said he had worked out the details of ten broad gauge lines in India, and they came to Rs. 1,64,000. These figures were taken from the Director-General's last report, and represented a good deal later information than Sir Donald Macleod's.

Mr. BLACK said these were engineering details which of course required closer examination. Mr. Parry had referred to a line of a thousand miles through the Arabian desert; but his (Mr. Black's) point was that it really was not a desert, a great portion of it was an old river bed, and was quite fertile. There was an idea on the part of some people that the Indian Government ought to supply the guarantee, but his contention was that such a line would be a benefit to both England and India, and that if there were a guarantee at all it should be a joint one. Mr. Wood referred to a second canal as a better means of providing against the delay caused by a stoppage of the Suez Canal; but if one canal could be blocked so could two. With regard to the eight days estimate, he understood that the P. and O. reckoned two days to Brindisi, and four days from Brindisi to Port Said, though he believed it was often done in three, which would leave three more for the transit from Port Said to Kurrachee. He should like to conclude by reading a portion of a letter he had only just received from the British Resident at Bagdad, under date 14th April, in reply to a letter he (Mr. Black) had sent to his predecessor: — "My object in writing to you now is to inform you that I will render you every assistance in my power. During my service in India of 31 years I have always been hankering after a line to connect India and the West, and when I got the news of my transfer from India to Bagdad the first thing that occurred to me was that I might now have an opportunity of pushing my scheme. It is a strange coincidence that on arrival here I find the scheme cropping up. As Rhodes remarked in connection with the righting of the Uitlanders' grievances, 'It must come—it must come,' and the only wonder to me is that the railway now projected has never been constructed." This was only a specimen of many letters he had received. He only contended that it was time this matter should be thoroughly inquired into with a view to action if found desirable.

Mr. MARTIN WOOD wished to point out that it was a mistake to speak of Baloochistan as a part of British India.

Mr. BLACK said when he was in the India-office, about seven years ago, he received an official map from India in which Baloochistan was coloured red; and since then British troops had actually garrisoned towns in Baloochistan.

The CHAIRMAN, in moving a vote of thanks to Mr. Black, said there could be no question about Persian Baloochistan. He was appointed, about twenty years ago, to decide the frontier line between Persian Baloochistan and Baloochistan belonging to the Khan of Kelat. Col. Holdich and the surveyors had been merely identifying the line he drew, not altering it in any way, as far as he knew. The Khan of Kelat was our ally, and his country might be said to be under British influence, but Persian Baloochistan was no more under British influence than Teheran or Ispahan.

The vote of thanks was carried unanimously, and the meeting adjourned.

Miscellaneous.

PATENTS IN 1896.

The Report of the Comptroller-General of Patents, Designs, and Trade Marks, for the year 1896, has recently been issued. It contains the usual very full statistics relating to the subjects with which it deals for the year 1896, with summarised statistics for previous years. The number of applications for patents, which has shown an almost steady increase since the Patent Act of 1852, has now reached the enormous number of 30,194—an increase of 5,132 on the number of applications for 1895. During the last two months of the year, the applications came in at the rate of 700 per week. The principal cause of the rise in patent applications is stated to be the development of the cycle industry, to which more than 5,000 of the inventions have reference. It is a remarkable fact that the number of patents applied for in the year under consideration, was more than double the total number of patents for inventions granted in the United Kingdom before the year 1852.

It is not too much to say that a vast majority of these inventions are absolutely worthless. Indeed, we may fairly assume that half them are admittedly so in the estimation of the inventor, since they do not proceed beyond the first stage. Under the previous Patent-law, that before the Act of 1883, the per-centage which were dropped at the first stage was a third. Only about six per cent. are considered worth keeping in force by payment of renewal fees for the whole fourteen years' term of their existence. Under the 1852 Act about ten per cent. endured during their full term.

Whether, on the whole, cheap patents are an advantage must remain a matter of opinion. There is a good deal to be said on both sides of the question. Even with the excellent system of indexing now available, the mass of material is so large that it is a matter of very great difficulty to find out whether an invention has not been anticipated.

It cannot be urged against the system that it involves a loss of revenue to the State, since the accounts for the year show a profit of £110,507. It was a matter of reproach under the old system that the Patent-office was made a source of revenue. But the surplus income seems to be approaching the amount earned when the fees were very much higher, the profit for the year 1882 having been £168,174. It is therefore evident that cheap patents are very nearly as profitable to the State as the more costly patents of the older system.

No reference is made in the Report to the retirement of Sir H. Reader Lack, who has held the important office of the Comptroller-General of the Patent-office, and who retired during the present year.

General Notes.

INTERNATIONAL PHOTOGRAPHIC EXHIBITION, 1898.—The Royal Photographic Society proposes to hold an International Trade and Technical Exhibition at the Crystal Palace next spring, and invites an expression of opinion upon the subject from the representatives of manufacturers and dealers, at a meeting of the trade, to be held at No. 12, Hanover-Square, W., on Tuesday, May 11th, at 3.30 p.m. The Council hope to make the Exhibition a complete and representative collection, fully illustrative of the development and present position of photography, in its widest sense, such as up to the present has never been held.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

MAY 12.—"Motor Traffic: Technical Considerations." By Sir DAVID SALOMONS, Bart. JOHN FLETCHER MOULTON, F.R.S., Q.C., will preside.

MAY 19.—"London Water Supply." By PERCY F. FRANKLAND, Ph.D., F.R.S. SIR DOUGLAS GALTON, K.C.B., F.R.S., will preside.

MAY 26.—"Silver and Prices: the Economic drain of Debtor Nations." By MORETON FREWEN, B.A.

INDIAN SECTION.

MAY 20, AT 4.30.—"Kerman and Persian Beluchistan, with special reference to the Journeys of Alexander the Great and Marco Polo." By CAPT. P. MOLESWORTH SYKES.

APPLIED ART SECTION.

Tuesday Evenings, at Eight o'clock:—

MAY 11.—"A Half Century of Line Engraving, 1780-1830." By GEORGE CLULOW.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock:—

LEWIS FOREMAN DAY, "Design in Lettering." Four Lectures.

MAY 10.—LECTURE II.—*Decorative Lettering.*—The Alphabet regarded more especially from the point of view of design—Its inherently decorative character—How far it was eventually affected, and to what degree shaped, by considerations of beauty—The art of the Calligrapher, his influence for good and evil—The relation of lettering to the implement, *i.e.*, the point, the chisel, the brush, the pen, &c., with which it is written—Penmanship *versus* printing—What decorative lettering should be, and what it should not be.

MAY 17.—LECTURE III.—*Ornamental Lettering.*—The Alphabet turned to deliberately ornamental purpose—How far that has been done, and how far successfully—Initial letters, as found in illuminated MSS., in early printed books, and in the books of to-day—The latitude allowed to the Artist in the design of initial letters and the like, and where he oversteps the bounds—Use before beauty—Ornament overdone—Legibility in lettering imperative—The exceptional cases in which the writer may mystify the reader—What we may do with the Alphabet.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 10...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Lewis Foreman Day, "Design in Lettering." (Lecture II.—Decorative Lettering.)

Surveyors, Savoy-street, Strand, W.C. Discussion on Mr. J. H. Redman's Paper, "Some Legal Incidents of Tenancies of Urban Property, as illustrated by Recent Decisions."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mrs. Bishop, "Recent Journeys in Sze-Chuan, Western China."

Medical, 11, Chandos-street, W., 8 p.m. Annual Meeting.

TUESDAY, MAY 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. George Clulow, "A Half Century of Line Engraving, 1780-1830."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. Tempest Anderson, "Volcanoes." (Lecture III.)

Iron and Steel Institute, 25, Great George-street, 10½ a.m. Annual Meeting. Inaugural Address by the President, Mr. Edward P. Martin. Reading of Papers and Discussions.

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Photographic, 12, Hanover-square, W., 8 p.m. Mr. Harold Baker, "Portraiture."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Sir Gilbert Carter, "The Colony of Lagos."

Asiatic, 22, Albemarle-street, W., 3 p.m. Annual Meeting.

WEDNESDAY, MAY 12...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Sir David Salomons, "Motor Traffic: Technical Considerations."

Geological, Burlington-house, W., 8 p.m.

Iron and Steel Institute, 25, Great George-street, S.W., 10½ a.m. Reading of Papers and Discussions continued.

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

United Service Institution, Whitehall, S.W., 3 p.m. Lt.-Col. Seton-Churchill, "The Defects of our Military Financial System. 1. For Peace. 2. For War."

THURSDAY, MAY 13...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Dr. Karl Lentzner, "Some Aspects of Art."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "Liquid Air as an Agent of Research." (Lecture III.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Mr. J. S. Raworth's Paper, "The Generation of Electrical Energy for Tramways." 2. Mr. A. P. Trotter, "Disturbances of Submarine Cable Working by Electric Tramways."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, MAY 14...United Service Inst., Whitehall-yard, S.W., 3 p.m. Mr. H. N. Sulivan, "The Formation of an Adequate Reserve of Trained Seamen."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. Harold Dixon, "Explosion-flames."

Astronomical, Burlington-house, 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Mr. W. Watson, "An Instrument for Comparing Thermometers with a Standard." 2. Mr. A. S. Ackerman, "An Experiment in Surface Tension." 3. Mr. D. K. Morris, "The Effect of Temperature on the Magnetic and Electric Properties of Iron." 4. Mr. Rollo Appleyard, "The Formation of Mercury Films by Electric Osmosis."

SATURDAY, MAY 15...Royal Institution, Albemarle-street, W., 3 p.m. Rev. J. P. Mahaffy, "The Greek Theatre according to Recent Discoveries." (Lecture III.)

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FRIDAY, MAY 14, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Mr. Lewis F. Day delivered the second lecture of his course on "Design in Lettering" on Monday evening, 10th inst.

The lectures will be published in the *Journal* during the summer recess.

APPLIED ART SECTION.

Tuesday, May 11, 1897; Francis Cobb in the chair.

The paper read was on "A Half Century of Line Engraving, 1780-1830." By George Clulow.

The paper, with report of the discussion, will be printed in a future number of the *Journal.*

CONVERSAZIONE.

The Society's *Conversazione* will be held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 16th June.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. In addition to this, each Member will be able to purchase additional tickets, the price of which will be 5s. each up to the day of the *Conversazione*; on that day the price will be raised to 7s. 6d. It is requested that Members requiring these additional tickets will make early application for them. Every application must be accompanied by a remittance.

Further particulars as to the musical and other arrangements will be published in the *Journal* later on.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The fourth meeting of the Congrès International de l'Enseignement Technique will be held this year in London, commencing on the 15th of June next, at the invitation of the Society of Arts, and of the Worshipful Companies of Drapers, Fishmongers, Goldsmiths, Merchant Taylors, and Clothworkers.

At the request of the Council, Her Majesty's Secretary of State for Foreign Affairs has issued an invitation to Foreign Governments to appoint delegates.

Further information respecting the Congress can be had on application to the Secretary, Society of Arts, John-street, Adelphi, London, W.C.

Proceedings of the Society.

INDIAN SECTION.

Thursday, May 6, 1897; Field-Marshal Lord Roberts, V.C., G.C.B., G.C.S.I., G.C.I.E., in the chair.

The paper read was—

KÁFIRISTAN: ITS MANNERS AND CUSTOMS.

By Sir George Scott Robertson, K.C.S.I.

The paper that I ask your indulgence for this afternoon is about a country which until lately was very little known, although it has been of great interest to ethnologists and other scientific men for a long time, and more particularly during the last half-century. The name of this country, Káfiristan, literally means the land of the unbeliever, just as Hindustan means the land of the Hindu, and Afghanistan the land of the Afghan. The word Káfir is applied by Muhammedans to all outside the pale of their own religion, whether they be wild tribesmen such as we are to talk about to-day, or civilised Christian nations like ourselves. A distinction is indeed made between Englishmen and others who venerate sacred volumes, the Bible, for instance, who are then called in Persian Kitábi Káfirs, and the heathen who possess no holy writings and are consequently termed Bekitábi Káfirs, or disbelievers without a book. Now this country, Káfiristan, the land of the infidel *par excellence*, is wedged in between Chitral, Badakhshan, with the other territories of the Amir of Kabul, and those Khanates north of Peshawar, of which you heard so much two years ago in connection with the relief of Chitrál. It is not necessary for us to consider its technical geographical position, but it is very important for you to remember that Káfiristan bears no resemblance to that India which commonly rises before the mind's eye when the name is pronounced; the India of yellow plains and fierce heat, or of tropical vegetation and terrific rains; the land of turbaned Orientals, of Gurkhas and Sikhs, the mighty theatre where the great Mutiny was enacted; India, the foster-mother of great Englishmen from Clive and Hastings down to Lord Roberts of Candahar. No; Káfiristan is a highland country with a fairly temperate climate. In the winter snow falls heavily and the cold is severe, but the summer heat, although intense, is not greater than that of Italy, for instance. Rain is infrequent, and crops depend chiefly upon snow water for existence. They receive it either directly or through the medium of irrigation channels. Wind is comparatively rare in the deep narrow valleys, of which the country is composed, although it is nearly always to be felt where least desired, that is to say, upon the summit of lofty passes.

I must try and give you some general idea of the country and of its appearance before attempting to talk of the people. I must, in short, attempt to set the scene before introducing the characters. Of course, the nature of the country, its vegetation, and its climate vary with the altitude. The highest village I visited was nearly 10,000 feet above the sea-level, the lowest was scarcely 3,000 feet. Between these two elevations there is room for much diversity, but the physical features of Káfiristan are remarkably constant. Its chief peculiarity is the absence of level expanses of ground of any but small extent. It consists of an irregular series of main valleys, for the most part deep, narrow, and tortuous, into which a varying number of still more difficult, narrower, and deeper valleys, ravines, and glens pour their torrent water. The hills which separate the main rivers one from the other are all of considerable altitude, rugged, and toilsome. As a consequence, Káfiristan, during the winter, is practically converted into a number of separate communities, with no means of intercommunication. The fact that for several months of the year many of the Káfir tribes are completely isolated from one another is one of great importance. It has obviously a strong bearing on the remarkable want of cohesion which is the most striking peculiarity of their political system.

All the passes leading from Badakhshan into Káfiristan are certainly over 15,000 feet high. I, myself, have only explored two of them, each of which was over the altitude mentioned, but I was assured that those were the lowest of the series. On the Chitrál side, the roads over the enclosing ranges, although somewhat less elevated, are still very high, and are completely closed by snow in the winter. There is one low ridge (8,400 feet) between the Kalash village of Utzun and the Káfir village of Gurdesh, but even that is closed for two or three months every year. All the passes leading to the Wai Valley, the Presumgul, and the Western Siah-Posh countries, with which I am acquainted, are steep, difficult, and high.

Some of the narrow valleys up which regular roads run are of the most picturesque and romantic description; others are bare rocky glens. Indeed many various kinds of scenery are to be met with according to the altitude and to other circumstances. At the lower levels fruit trees abound, and in the hot weather the traveller pushes his way along the torrent's bank, through thickets and tangles of wild grapes and pomegranates. At such elevations splendid horse-chestnuts and other shady trees afford pleasant resting places, while the hill slopes are covered by shrubs, wild olive and evergreen oaks. At somewhat higher altitudes, say from 5,000 to 8,000 or 9,000 feet, dense pine and cedar forests abound. They are composed of magnificent trees which with a snow background afford delightful prospects. Higher still, the pines cease; the hills are then almost bare, rocky or shaly; while the willow, birch, and the juniper cedar are the chief trees met with and the wild rhubarb grows abundantly. Still higher—that is to say at about 13,000 feet—there is no vegetation of any kind except rough grasses and mosses.

The rivers as they descend the corkscrew valleys and are fed by subsidiary streams from the ravines, glens, or mountain recesses, increase in velocity until they become raging torrents, dashing against the huge boulders which obstruct their course, and flinging high their spray with deafening uproar. In many places where the water foams and lashes itself against the rocks on its margins or in its bed, the river almost assumes the nature of a cataract, and is indescribably beautiful. Tree trunks encumber the water way, jamb themselves against the rocks, pile up in picturesque confusion or hurry round and round in the swirl of a back water. For lovers of wild scenery many parts of Káfiristan could not be surpassed anywhere. In the autumn and winter months many of the valleys are in shadow very early in the day and are strangely sombre and mysterious.

The main roads of communication, if roads they may be called, are almost invariably along the river banks, so narrow and steep are the valleys. They are nearly always extremely difficult. It is rare to find even a couple of hundred yards of moderately level ground, and, in marching it is usually one incessant clamber over rough stony tracks, which traverse low spurs and bluffs, though sometimes the road, by means of precarious wooden galleries, is carried across the face of precipitous cliffs. Frequently it is most difficult to get over the smooth, slippery surfaces; indeed, in some positions the inexperienced or badly shod traveller can only proceed by edging himself along in a sitting position. In a word, journeying through Káfiristan is exceedingly arduous. Of course, horses cannot be taken, and in some places even dogs cannot get along without help. Bridges are of various degrees of excellence, or perhaps I should say, badness, and, in many cases, it requires resolution and good nerves to use them. Even the best vibrate and sway abominably, while parapets are rarely more than six inches high, and are, as a rule, absent altogether.

But now of the people themselves. I have lately published a book which deals with their manners and customs at considerable length. So bearing this in mind, as well as the shortness of the time at my disposal, it will be better for me, I think, with your permission, to say nothing more on that subject now, but trust to the pictures you will shortly be shown, and to the explanatory remarks I shall offer about each, to give you some general idea of Káfir villages, houses, and temples. In the same manner you will get exact information about the clothing, the weapons, and the utensils of this interesting people, as well as correct knowledge of certain of their customs, occupations, and dances. There are also here to-day certain specimens of wearing apparel, ornaments, arms, carved wooden vessels, dancing and other axes, walking sticks, &c., &c., which I brought home with me from Káfiristan. If anyone is desirous of pursuing the subject still further, I can only refer him to my book, which embodies all the knowledge I was able to acquire during my twelve months' residence in Káfiristan.

Now, first of all, we are confronted with the questions, who are the Káfirs? Whence did they come? Much has been written on these two points, much that is both learned and ingenious, which want of time prevents me from referring to further. These problems do not appear to me so complex as they do to some. Indeed, the explanation, to my mind, is to be found in Káfiristan itself. At least that measure of explanation which is common to all the surrounding territories when similar questions are asked concerning their population. The true answer is that the Káfirs are not an unmixed race. They are clearly the remnants of different peoples. At least three absolutely distinct languages are spoken in Káfiristan at the present day, while mere differences of dialect are very numerous.

I may mention here that it is astonishing what a large number of tongues are spoken all round this out-of-the-way corner of the world Take, for example, the Nursut people of six villages of the Kunar Valley, the so-called Gubbars, who declare they were originally an outcast tribe of fire-worshipping Persians before their conversion to Islám. These people speak a particular language. The Minján and the Lutkho villagers have also a separate and distinct tongue, while two little communities near Kila Drosh have a speech which none of their neighbours can understand. When you add to these the Persian, Pathan or Pushtu, the Kalash, the Chitrál, the Shín, and the Burish languages, not to speak of Urdu and many other tongues, you can form some idea of the ethnological tangle which awaits unravelment all along this frontier.

But to resume; it seems to me that the majority of the Káfir tribes are of comparatively recent arrival in the country. They must have come as conquerors, retiring no doubt before an irresistible enemy, for no people would settle in Káfiristan if they had option in the matter. This is also their own account of themselves. On their first arrival, they say they found the valleys inhabited by a mild race of what we may perhaps call aboriginals. They were people of gentle manners and strong superstitions, whom they either enslaved, amalgamated with, slew, or drove into the high, cold and least hospitable parts of the country. I believe that I visited this ancient people when I travelled through the Presungul Valley. They are a tribe that seems naturally to burrow underground, and instinctively to seek a refuge in the rocks like other feeble folks, when pressed by an enemy. Such is the difficulty of their language that I could not remember a single word of it, while the Bashgul Káfirs with me declared that none of their tribe could ever speak the tongue, no matter how young he was when he first heard it. Another people, called the Zhazhis, remnants of which are still to be found in the Bashgul Valley, are always spoken of by the Káfirs as descendants of the ancient possessors of that part of the country. There is nothing distinctive about them now, in language, religion, or habits. Eight centuries have obliterated all such peculiarities, and have assimilated their manners and customs to those of their conquerors. But I have a suspicion that a certain lower stamp of features, constantly to be met with, and in striking contrast to the Aryan type which prevails everywhere else in this part of the Bashgul Valley, is to be explained by the intermarriage of the two races. The slaves, again, appear to be the descendants of a very ancient people. Some, it is true, may have had for ancestors prisoners captured in war, but if there are any such their number is small. A slave, or a mean man just above the grade of servitude, is generally recognised at once by his coarse, heavy features, although there are exceptions to this rule, who may perhaps be considered the mulattoes or quadroons of the class.

If my assumption is granted, and it seems to be plausible, not only from what I have said, but from analogy also, that a portion of the present inhabitants of Káfiristan represent a very ancient, what we may almost call an aboriginal people, the questions still to be answered are—whence and when came the later arrivals? We may presume, I think, that they did not enter the country until they were compelled to. It also seems clear that they could not have come from Chitrál or from the East. They are obviously not of Tartar blood. They must, then, either have come from Badakhshan, Afghanistan, or from the Peshawar direction. This is practically their own version of the matter. Some tribes say, vaguely, that they came from the West; others relate that the Salarzai or the Mohmund territory was their former home, while a few men have proudly informed me that their old frontiers included the whole of the Swát district. Another point is they all associate their original entry into Káfiristan with fighting. All the wild stories about Gísh, the war god, and the havoc he wrought in Arabia, how he played with Hazrat Ali's head, trundling it along the ground by means of a stick and so forth, all sound like echoes of a mighty conflict with the Moslems, a conflict which has continued almost to the present day.

In the 11th century, when the fervid followers of the prophet of Arabia overran Eastern Afghanistan, they must have found there a large Indian population. It is, in my opinion, the unconquerable remnants of this Indian people, together with fugitives from certain other tribes inhabiting the fertile lands which border Káfiristan, that are the ancestors of the majority of the Káfir tribes as they exist to-day. If this view is correct, we must look for a similar people to the Káfirs amongst the Sarts and other non-Afghan elements in the population of Eastern Afghanistan, and amongst the people on the Peshawar side as well, and we must not look much further than this. We ought also to seek among the tribes of the Punjab, or amongst still more distant non-Muhammedan Indian peoples for points of similarity in language, religious ceremonies and customs. Marked success in this respect cannot be anticipated, first because of what may be almost called the fluidity of the Brahmin religion, its power of absorption, or of modifying itself; that endless change which is the secret of its changelessness; and, secondly, because you have to consider what must happen, in eight centuries, to a race of plainsmen transferred to a stern mountain country, where the struggle for life was intense, and where they found other idolatrous tribes with gods and superstitions to be assimilated in the usual tolerant pagan fashion. Everyone knows how environment affects the manners and habits of a people, how the scrupulously clean Brahmin of the plains of India is represented in Kashmir by the Pundit, a very imperfect ablutioner; how the man who lives exclusively on the produce of his fields must trust chiefly to his flocks and herds if he finds himself in a land where the cultivatable area is scanty, and where he is ever liable to have to retreat before an invader. There are many little facts which might be brought forward in support of my contention, if time would permit; facts relating to the Káfir religion, the physical characteristics of the people, their belief in the uncleanliness of certain animals, fowls, for instance, the position of slaves and the probability that it was the late comers that brought this institution with them. I might mention as a small fact bearing on this question the finding of a sculptured slab near Murdán, upon which a youth is shewn seated on a stool exactly like those used by the Káfirs at the present time.

I hope before long to get leisure to carefully revise my vocabularies and other compilations of the Bashgul language, and then discover if they throw any light on this interesting question.

Before quitting this portion of my paper, I would say, that supposing it were asked if the Greek colonists of Alexander and the Bactrian Empire had had any influence on the Káfirs, the reply ought to be, in my opinion, "Certainly and obviously; to precisely the same extent as such influences were felt everywhere else on the borders of Káfiristan." No doubt, in the 11th century that power and influence had grown weak; it had been thinned of its best parts and loaded with impurities during its filtration through the Brahmin kingdom of Kabul. But such as it was it must thereafter have been felt more in Káfiristan than elsewhere, although it has been gradually diminishing ever since amongst a people who could not progress, nor from the circumstances of their lives and isolation, do other than deteriorate. Nobody, I suppose, believes that Alexander actually visited Káfiristan, for not only is there no proof of such a journey, but there could not have been any occasion for it. Genghiz Khan and the Mongolian hordes, although they invaded Chitrál, never seem to have entered the Káfir country. As far as I know, and as far as I could learn, there are no Buddhist remains in Káfiristan.

Of the religion of the Káfirs it will be sufficient to say that it is a degraded form of idolatry, suggestive of Hinduism of a very low intellectual type. There is some evidence also of the adoration of ancestors, and perhaps some faint traces of fire worship as well. Here, again, it looks as if several heathen religions have been jumbled up together. The only indication of human sacrifice is when prisoners are slain in front of the coffin of a great man, recently killed, or when slaves are handed over to the relations of murdered people, not as compensation or fine, but to be stabbed in order that their death may satisfy the indignant ghosts of the deceased. This is probably not human sacrifice at all, but simply the stern old law of blood for blood. For the rest, the remarkable point about the Káfir religion is its extreme tolerance and its want of assertiveness. Indeed, religion was at a low ebb everywhere when I was in Káfiristan, except in the Presungul Valley, where the people were obviously most devout. I was warned that to carry fowls with me or eggs would give great offence. It may even be said that those men only wanted greater manliness of character to become fanatics. Upon my first arrival in that valley the people were nervous, and dubious about showing me their gods, until my companions, the Bashgul men, mendaciously declared that I was a Káfir like themselves. Afterwards they were most friendly, but never quite frank in letting me see their holy places, although they were willing enough to show me their idols. To give you some idea of their conceptions on religion, I may tell you that when bidding them good-bye, before leaving their country, a deputation of priests and headmen came to request me to ask Imra (the Creator) to make their country a little warmer!

All the other Káfir tribes were evidently ripe for a change of faith. They attributed wisdom, power, and superior skill, especially in medicine, to the learned mullahs (or Moslem priests). A slight altercation between father and son was not unfrequently followed by the youth leaving his home and embracing Islam, although I am bound to confess that he reverted to his own religion with equal ease. The strongest argument a wise old woman advanced in favour of the Káfir, as opposed to the Muhammedan faith, was that in Káfiristan you got really good food, and were never expected to eat dry bread without even curds or cheese—a common incident it seemed among the Islámites. There is little doubt that religious progress in Káfiristan was progress towards Muhammedism. It meant an advance in civilisation certainly and for the largest portion of the community, the feminine, it was an immense stride in morality and in material happiness. Nothing could be more terrible than the position of Káfir women. Public opinion about them and their own opinion about themselves, and their position in the world, were equally deplorable. It could not be lower than it was. Speaking generally then the Káfirs were prepared for a religious change. They had no strong antagonism to Islám. What antagonism there was had to be kept at a proper heat point with considerable difficulty. The war of centuries which had begun with a conflict of creeds had for ages been sustained solely by race hatred—the reciprocal detestation of Afghans and Káfirs.

It is now necessary to say something about the political organisation of Káfiristan and to show the inherent weakness of the system. This, taken in conjunction with what I have said concerning the distinct tendency on the part of the Káfirs to admiration of the Mussul-

15,171 represented Swiss houses, while 4,496 were engaged on account of foreign firms as follows:—German, 2,952; French, 1,051; Italian, 235; Austrian, 129; English, 50; Belgian, 42; Spanish, 18; Dutch, 14; North American, 4. The provision trade appears to employ the largest number of travellers in Switzerland, 6,735 altogether in 1896; the wine trade 3,159, and the textile trade comes third with 4,633 travellers.

SPANISH BULL-FIGHTS.—The United States Consul at Barcelona says that, "During the latest bull-fight season, from April 5th to October 20th, 1896, there were 478 bull-fights in Spain, and 1,218 bulls, valued at £60,000, and 5,730 horses, valued at £40,000, were killed. The number of matadores was 23, and they were paid for their services in all 1,329,000 pesetas, or £53,860. The less-renowned matadores received from £60 to £80 for each fight in which they took part, while the most renowned received from £100 to £170. The famous Guerrita appeared in 68 fights, killed 174 bulls, and received in all £10,250; Bombita fought 43 times, killed 112 bulls, and was paid £4,250; Mazzantini was in the ring 29 times, killed 68 bulls, and made £4,350. They were the favourite matadores. Some only appeared in the ring once or twice, and they were those who received the smallest remuneration. It cannot be truthfully said," remarks the Consul, "that the interest in bull-fighting is diminishing in Spain, on the contrary, it seems more intense than ever."

ITALIAN CORAL.—The coral industry, which is of considerable importance in Italy from the maritime point of view, also employs both capital and labour for working up the raw material procured by the fishermen. Leghorn and Naples, and particularly the former, are the great centres of the coral-working industry. There are no complicated processes, it being only necessary to select from the rough material the better qualities according to colour, and the better portions of such qualities, and to form them into beads of various shapes to suit different markets. The work is almost entirely done by girls, who saw, turn, file and polish the raw material. Prices vary greatly according to the shades of colour and to the size of bead of uniform shade which can be produced. "Of late years the average price has fallen considerably," says Mr. FitzGerald Law, Commercial Attaché, "owing to the increased production of what are considered inferior qualities, but the price of the best-coloured coral remains very high, reaching exceptionally to as much as £12 per ounce." The exports of coral, rough and worked, amounted in 1895 to somewhat over £1,000,000 sterling. About 60 per cent. of the exportation is to British India, and the demand for the African market is said to be most promising for the future.

HEMP CULTIVATION IN BOLOGNA.—One of the most important agricultural products of the provinces of Bologna and Ferrara is hemp (*Cannabis Sativa*). Bologna hemp is generally manufacture into yarns and canvas. The Ferrara quality is principally used for rope making. The former is a fine fibre than the latter, but not so strong; they ar both however held in high esteem in textile centre abroad, according to the United States Consula Agent at Bologna, chiefly in Germany, France an Spain. The cultivation of hemp has greatly developed in Bologna and Ferrara, owing to the favou able conditions of the climate and soil, which are n easily found in other countries. Hemp may be cult vated between the equator and 60° latitude. Chem cally the land must be siliceous, argillaceous, calcareo and rich in azote. Physically it must be soft, fre and deep. In addition the land must be abundant manured. Sowing generally takes place in the sprin owing to the necessity of a temperature of 46 Fahrenheit, and a moderate degree of humidity. is preferable to sow by machine, this system savi seed, and the sowing being much more regular. T land must be previously deeply ploughed. Aft sowing the land requires to be hoed, and much oth work is necessary, such as the extirpation of wee &c, in order to obtain an abundant crop. The cr ripens in August or September according to t weather. It consists of stalks about three met long. These stalks are placed in bundles and p into ponds expressly constructed, where they rem about a week. They are then dried and scutched means of a complicated process, which produces t fibre ready for market.

MEETINGS FOR THE ENSUING WEE.

MONDAY, APRIL 12...Sanitary Institute, 74A, Margaret-str W., 8 p.m. Dr. George Reid, "Sanitary Ap ances."

British Architects, 9, Conduit-street, W., 8 p Mr. H. Heathcote Statham, "The New Gov ment Offices Scheme."

Camera Club, Charing-cross-road, W.C., 8¼ p Mr. Campbell Swinton, "Some Recent Invest tions in X Ray work."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p Dr. Schofield, "The Scope of Mind."

TUESDAY, APRIL 13...Medical and Chirurgical, 20, Hano square, W.. 8½ p.m.

Civil Engineers, 25, Great George-street, S. Discussion on Messrs. David Hay's and Ma Fitzmaurice's Papers, "The Blackwall Tunnel

Photographic, 12, Hanover-square, W., 8 p.m. r. C. F. Townsend, "Colour Measurement in Ph graphy."

Colonial Institute, Whitehall-rooms, White place, S.W., 8 p.m. Sir Donald Smith, "We Canada."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 n.

Asiatic, 22, Albemarle-street, W., 4 p.m.

THURSDAY, APRIL 15...Linnean, Burlington-house, W 8 p.m. 1. Mr. A. A. Walker, "Some New sh Crustacea." 2. Messrs. W. and G. S. W st, "Desmids from Singapore." Exhibition of P ts collected during Two Years' Residence in F Josef Land, by Mr. H. Fisher.

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FRIDAY, APRIL 16, 1897.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The fourth meeting of the Congrès Inter-
ational de l'Enseignement Technique will be
eld this year in London, commencing on the
th of June next, at the invitation of the
ociety of Arts, and of the Worshipful Com-
anies of Drapers, Fishmongers, Gold-
miths, Merchant Taylors, and Clothworkers.

The Congress will be opened at 11 o'clock,
n the 15th of June, by an address from the
resident, the Duke of Devonshire, K.G.

The subjects for discussion at the Congress
ill include:—

Technical Education:—

1. Advanced Instruction. Polytechnics, Universities, Colleges.
2. Secondary Instruction. Higher Technical Schools; Secondary and Intermediate Schools; Evening Schools.

Commercial Education:—

1. Advanced Instruction. Colleges; High Schools and Institutes of Commerce.
2. Secondary Instruction. Commercial Schools; High Schools; Classes for Adults.

It is not proposed to deal with elementary
echnical or Commercial Education. The
lucation of both sexes will be included.
urther information will be issued at a later
ite.

The Executive Committee will be glad to
ceive offers of papers coming within the
ope of the subject as above defined. The
ipers must be in the hands of the Secretary
t later than the 29th May.

The papers will be printed and distributed
the meetings. They may be in French,
erman, or English, and speakers may make
e of any of these languages.

All communications relating to the business
the Congress should be addressed to the
cretary, Society of Arts, John-street,
delphi, London, W.C.

JOURNAL ADVERTISEMENTS.

From the present date all arrangements connected with the advertisements in the Society of Arts *Journal* will be in the hands of Messrs. Street Brothers, 164, Piccadilly, W. All communications, therefore, referring to advertisements should be addressed to Messrs. Street.

Proceedings of the Society.

INDIAN SECTION.

Thursday, April 1st; Field-Marshal Sir Donald M. Stewart, Bart., G.C.B., G.C.S.I., in the chair.

The Chairman stated that Mr. O'Dwyer having returned to India, the paper would be read by the Secretary of the Section.

A VISIT TO RUSSIAN CENTRAL ASIA.

By Michael Francis O'Dwyer, I.C.S.,
Director of Land Records and Agriculture, Punjab.

The tribes and cities of Central Asia—Merv, Bokhara, Samarkand, Tashkent—must always exercise a peculiar fascination for the British traveller, especially if he happens to be connected with India. They appeal alike to the ethnographic, the archæological, the historical, and the political instincts, and offer a rich mine—which has not yet been fully explored—for antiquarian and historical research. The conquest of the Khanates by Russia within the last thirty years has, in a sense, added to their interest as offering another example, which may usefully be compared with India, of the result of the impact of new forces—physical, mental, and moral—on the ancient and stereotyped Mohammedan semi-civilisation of the East, and affording us a means of testing the success of the assimilative capacity of the Russian conquerors.

Hence it was that after spending a winter in Moscow, and acquiring some knowledge of the vernacular, I determined, in company with two friends, also members of the Indian Civil Service, to take advantage of the thaw—always an unpleasant time in Russia proper—to pay a flying visit to Central Asia, returning to Moscow in time for the Coronation. Our object was to get as far as Samarkand—seeing Merv and Bokhara on the way—by rail; push on to Tashkent, and, if possible, to Khokand, the capital of the rich and rapidly-developing province of Ferghana, by road; and return from Khokand direct to Samarkand, and so back to the Caspian by the same route.

or rivers, and when crops are poor, or the snow fall is scanty, the old heathen sacrifices will still be offered in secret to the supernatural powers. But Gísh, the war god, must go. It was his worship which greatly helped to keep Káfiristan free for so many generations. Now his blood-stained shrines are already demolished, and the mosque of the orthodox Sunni has replaced the temples of all the fantastic deities. The high falsetto shout of Allah Akbar (God is most great) will call to prayers, and the twirling, stamping, shuffling throng will no longer sing the praises of Imra or Gísh, as they proudly dance before their admiring neighbours. The wine presses will be idle, austerity will be cultivated, and the wild frank gestures of the elders of the peoples will be altered for disciplined and decorous movements. Self-righteousnsss and spiritual pride will surplant picturesque ceremonial and good-humoured tolerance. One sighs to think of the change which has occurred, and then stops in doubt if it is right to sigh. The world has gone on for the Káfirs, it will be less bloody, gentler than it was, for it could not be otherwise, but——. However, it is useless to moralise.

> "The moving finger writes; and having writ,
> Moves on; nor all your piety nor wit,
> Shall call it back to cancel half a line
> Nor all your tears wipe out a word of it."

I will now try to illustrate some of the ways and manners of Káfirs by lantern slides. It may be as well for me to explain, that all the pictures that will be thrown on the screen are of distinct scientific value. The great majority have been carefully drawn from my photographs by Mr. McCormick, who has, in my opinion, performed his task with great success. His results are, to my mind, as beautiful as they are undoubtedly accurate. When in Káfiristan I took a very large number of photographs, mostly snap-shots, with a fair measure of success; but they did not come out sufficiently well to make good lantern slides without the intervention of a skilled artist. One or two of the dimmer pictures are taken directly from my films and you will at once perceive how they differ from the others.

The Chairman said they might consider themselves very fortunate in hearing from Sir George Robertson's own lips the story of that strange unknown country called Káfiristan. He called it unknown, because if they referred to gazetteers where it was mentioned they would find very little about it. In 1885 Colonel (now General Sir William) Lockhart penetrated as far as the Bashgul Valley and remained there a short time, and then, from circumstances over which he had no control, was obliged to return to Chitral, intending to go the next year into Káfiristan by the Dorah Pass. That intention, however, he could not fulfil, owing to the Amir of Cabul protesting against his entering his territory, and consequently the Government of India desired him not to go. From that time no European had visited Káfiristan until Sir George Robertson, in 1889-90, made those two remarkable journeys of which he had given such an ample description in his book on "The Káfirs of the Hindu Kush." One could have wished there had been more time to hear of his narrow escapes and thrilling adventures, but they were all excellently described in that most interesting work. He quite agreed with him that the Society of Arts was not the place for a political discussion, but the members would perhaps not think it improper of him to say that the interest they all took in learning all they possibly could about that part of the world was considerably enhanced by the probability that some day—though it might be a long way off—it might play a prominent part in the question of the maintenance of our power in the East, and the safety of that vast Empire where the British flag waves over 300,000,000 of souls of various colours and creeds, where Christian, Káfir, Mussulman, Hindu, and Buddhist live peaceably together under the rule of her Majesty Queen Victoria, and where the same freedom of speech and of action, and the same security for life and property exist as in our own happy island. It was not only desirable, but absolutely necessary that we should take every opportunity possible of ascertaining all we could about the country and the wild tribes inhabiting the country adjoining the North-Western frontier. Thanks to the courage and energy of many Indian officers and our native fellow-subjects, we were ept pretty well up to date in these matters, and thanks also to men like Sir George Robertson, we got useful information about countries even beyond those immediately adjoining the frontier, as well as of the peculiarities of the people, and of the geography of the country, and he hoped when the day of trouble came these people would be found valuable allies, whereas but for this acquaintance with them they might be found to be dangerous enemies. In thanking Sir George Robertson for his interesting and instructive paper, and Mr. McCormick for his artistic assistance in preparing the illustrations, he thought that all present would endorse the words with which Shah-i-Mulk greeted Sir George when he returned to Chitral. "What you have been telling me is all very wonderful; but the most wonderful thing of all is that you have returned yourself."

Sir Steuart Bayley, K.C.S.I., C.I.E., said the hour was so late, that he would rather be excused discussing the paper, but he thought the reader might be congratulated on having such a distinguished audience—the largest he had ever seen in that room—the audience might be congratulated on the interesting paper and pictures which had been put before them; the Indian Section might be congratulated on having brought Sir George Robertson and the audience together; and they all might be congratulated on having such an honour done them as Lord Roberts of Candahar coming to preside.

TWENTIETH ORDINARY MEETING.

Wednesday, May 12, 1897; JOHN FLETCHER MOULTON, Q.C., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Barker, Gerald, 1, Victoria-street, S.W.
Chrimes, Charles Edward, Selwood, Rotherham.
Dyson, Robert, Fairfield, Rotherham.
Powell, Harry J., 26, Tudor-street, Whitefrrars, E.C.
Rodda, Edward Duncoff, 6, Gold-street, Roath, Cardiff.
Zeal, Hon. Sir William Austin, K.C.M.G., M.L.C., Melbourne, Victoria.

The following candidates were balloted for and duly elected members of the Society:—

Garibaldi, Joachim A., 21, Church-place, Gibraltar.
Gissing, Captain Charles Edward, R.N., 40, Albany-mansions, Albert-bridge-road, Chelsea-reach, S.W.
Levenstein, Ivan, Hawkesmoor, Fallowfield, and 21, Minshull-street, Manchester.
Mackay, Sir James Lyle, K.C.I.E., 7, Seamore-place, Mayfair, W.
Malthus, Colonel Sydenham, C.B., Dalton-hill, Albury, Guildford.
O'Shaughnessey, James Edward, St. Mark's-square, Bangalore, S. India.
Rhodes, William, Beverley, Chatsworth-road, West Norwood, S.E.
Stirrat, John, Town Hall, Rangoon, Burma.
Taylor, H. W., Semaphore-chambers, Kalgurli, Western Australia.
Williams, Arthur Edward, Dagenham Dock, Romford, Essex.
Wood, Walter C., care of Messrs. Buchheister and Co., Ningpo-road, Shanghai, China.

The paper read was—

MOTOR TRAFFIC: TECHNICAL CONSIDERATIONS.

By SIR DAVID SALOMONS Bart.

My audience will probably think that it is presumptuous on my part to read another paper on the well-worn subject of self-propelled traffic on the highway.

An excellent series of lectures was delivered in this room by Mr. Worby Beaumont, which dealt mainly with the history of the subject. Mr. Cunynghame also read a paper here of very considerable interest, while elsewhere, a great deal has been written and said on the same question, by others as well as myself, covering a sufficient amount of paper to light the fires of a large household through a long winter.

Probably no lover of music would be bold enough to assert that because millions of melodious combinations have already been produced from a limited number of notes on the piano, that at no future time may we expect further combinations likely to produce a pleasant effect on the mind. May I, therefore, venture to think that in dealing with the various points bearing upon the question of self-propelled traffic, there yet remain possible combinations which may prove of interest to an audience. If the proposition be true, you will possibly allow that in addressing you on this subject once more, the presumption is not so great as it might at first sight appear.

I do not propose, on this occasion, to discuss the pros and cons of motor traffic, as to where its uses and abuses lie, but to deal with the matter rather from a technical point of view, and to examine the Patent-law, so far as it affects the question. The former has been already attempted, but not to my mind, in a satisfactory manner. Too much history has been mixed up with the subject, as well as loading it with pure theory.

The interest I have taken in the matter has led to the forming of a large collection of books, old and new, dealing with road traction, as well as prints and engravings illustrative of the same subject. Indeed, I doubt whether anyone has a more complete collection of the kind, and a careful perusal of the various volumes and plates is most instructive.

The two chief lessons to be learned by their study are the following:—

(1) How few patents taken out recently in connection with the subject are original.

(2) How the whole tendency of the construction of light vehicles gravitates to the better types of those in existence between the years 1820-30.

We, of course, possess an advantage over the constructors of that period, inasmuch as we have improved materials to deal with, and can therefore produce a better kind of engine and boiler, in the case of steam.

Much surprise has been expressed by the

uninitiated, not even excepting many engineers, as to the reason why the horse-power to be carried on the motor-propelled vehicle, should be greater that when the living horse is employed. I will examine this question first.

You will fully realise that if carriages had wheels no larger than the ordinary reel of cotton, the usual obstructions to be found on highways would generally be as high or higher than the diameter of the carriage wheels, so that when the obstructions were met by the wheels, if the former were loose they would be pushed along, and, if fast, progress would become practically impossible and the wheels would be destroyed, or wrenched off, before the vehicle had proceeded many yards.

On the other hand, if the wheels were to be, say 30 feet in diameter, even considerable obstructions on the road would not be materially felt, as the wheels would pass over them with the utmost ease. In practice, such large wheels could not be used.

I will, therefore, suppose that the usual diameters as generally seen on carriages are employed, when dealing with this subject, so that the wheels are from, say, three to five feet in diameter.

We all know why, thanks to the careful investigations of the late Mr. Froude and others, the fish moves with such freedom in water, when it is completely immersed, the reason being that the power necessary to divide the water in advance is compensated for by the closing of the water behind the fish, which gives it a push. Its curved outline is so admirably formed that the fish is capable of moving through the fluid in which it lives with virtually nothing more than skin friction to be overcome.

The same might be thought to take place in the case of a carriage rolling along a rough road, *i.e.*, the extra power required to get the wheels over an obstacle should be compensated for by the downward run when descending the other side. To some extent the theory would hold good for exceedingly rapid motion, but not for speeds permitted on high roads, and for the following reasons.

It is evident that a wheel, in surmounting an obstacle, rises gradually, but descends through a less distance as a rule, because the obstacle, a stone for instance, has probably been sunk into the ground or broken smaller by the wheels' passage.

But supposing no crushing action takes place, as might well be the case with a light vehicle, then why should the work be harder to pull it over a rough than a smooth road? The answer is, that in passing over a rough road, the speed being slow, the sum of the pulls necessary to get over the obstructions are far greater than the sum of the accelerating forces on descents, owing to the tendency of the wheel to push into the ground before surmounting the obstacle, and this applies in all cases.

If the obstructions on a highway consisted of a series of symmetrical waves, switchback in form, it is clear that the carriage would run slowly up an incline, and more quickly down. The average power used, supposing these undulations to be on an otherwise good road, would be no greater than had these undulations not existed, although the carriage would have advanced by fits and starts.

In giving these various explanations, I have assumed that the horse is drawing the vehicle, and the line of draft is, therefore, at a point somewhat higher than that of the axles, in other words, inclined backwards to the road, which is a great advantage because the pull tends to lift the wheels over the obstructions.

Supposing, now, we place the horse behind the cart, and make him push it with his chest, what would be the result? The wheels, instead of being assisted in surmounting obstructions by the lifting tendency, would now tend to drive themselves into the ground behind the obstruction, and the horse, which might have advanced with the greatest of ease when placed in front, would have his work cut out to push the cart from his new place.

Here we have the condition imposed upon a self-propelled vehicle. This difference between dragging and pushing is well shown in the case of a railway truck on which porters move passengers' luggage. If the truck, when loaded, meets with an obstruction, the only way to advance easily is to turn round and pull it along.

I should like for a moment to consider the manner in which the power is derived from the horse. Of course, we must all admit that primarily it is muscular action, but most people think that a horse advances solely in consequence of the anchorage obtained on the road by means of its feet, whereas there is another very important action brought into play, which those who watch these animals carefully, will easily observe.

It is well known that a heavy horse can drag a greater load than a light horse, and I think, when you consider the special point to which I will refer, the reason is very obvious, although of the two horses in question one need not have greater muscular power than the other. Riders are aware that during a trot, and indeed at all times, the body of the horse rises and falls. The rising of the horse is due to muscular power exercised against gravitation, whereas the fall is due to gravitation alone. Since the horse is advancing during the time, a curve of a wave-shaped form would represent graphically the rise and fall of the horse's body. It, therefore, appears evident that there is during half the period of advance, a time when gravitation materially assists the progress of the vehicle, and the greater the weight of the horse the more it will be in favour of the load being pulled. Consequently, the heavy horse has an advantage over the light one for heavy loads.

It appears to me that this, what I would term undulatory advance, is in a large measure equalised by the spasmodic advance, due to the horse's feet pushing against the road, and here is to be found one of the chief reasons why the carriage runs with smoothness.

No motor has ever yet been devised combining these two properties. Gordon and others invented vehicles with feet to imitate the progress of the horse, but the rising and falling of the heavy weight was absent in these devices, and may possibly have been the reason why they proved complete failures. It may readily be imagined how jerky the advance would be without this compensating governor.

A few words respecting pneumatic tyres are not out of place.

An ideal road would be one of a hard elastic surface capable of permitting all inequalities to sink into it without friction, when the wheels meet any obstruction lying upon it. Such a road in practice cannot exist. It is, therefore, necessary to seek a means which will produce the same result. A pneumatic tyre, suitably constructed, will give the equivalent of the ideal road, *i.e.*, the obstructions which the tyre meets will sink into it, and the travelling load will not be raised against gravity. Losses by friction, however, remain the same.

The advantages to be derived from the use of the pneumatic tyre cannot, however, be gained except by encountering many other troubles, of which those who use this class of rim are well aware. They may be summed up as the mechanical defects of the system.

There is a popular notion that by the use of the pneumatic tyre advantages are always gained. This only is true if certain conditions are observed.

It is evident that unless the tyre is inflated to a proper degree, which must be regulated by the load, also unless it is of sufficient diameter that the stones most generally met with on the road will sink into the tyre—the pneumatic, so to speak, must swallow all the obstructions it meets with in its path—its main virtue would be gone.

Personally, I do not view with the utmost favour the pneumatic tyre, on account of the mechanical disadvantages. Indeed, if the springs of a carriage are sufficiently well made and adjusted, a circumstance rarely to be found, the advantage of the pneumatic is almost absent, and I believe that for motor traffic the steel or solid rubber tyre will prove the favourite in the long run, when sufficient attention is given to carriage springs. The chief function to be fulfilled by the carriage spring is to enable the load to travel on the level whilst the wheels of the under carriage are mounting up and down as they pass over road obstructions. The weight of the portions which rise and fall are very small, compared with the vehicle and its load.

Although it has been asserted that the draft is greatly diminished by the use of pneumatic tyres, my own experience does not bear this out except in given cases. On bad roads an advantage may be gained, but on good ones, the steel tyre carries the palm. Quite apart from experiments, it is only necessary to watch the pull exerted by a horse on various classes of roads with the same carriage tyred in different manners.

It is found that the rubber of the pneumatic tyre will burn if the load is very heavy. Whether this is due to the successive compressions of the air when meeting obstructions on the road, or whether it is owing to the friction of the air in the tube, due to lag in having to pass through a very restricted opening in a portion of the tube, *i.e.*, that part which is in contact with the road, and to friction generally, it is difficult to say. The fact is there. Messrs. de Dion and Bouton had the greatest trouble on this score with their tractors, and finally decided to fall back on the solid rubber.

It is quite possible to make a pneumatic tyre suitable for very heavy roads, but the thickness and size would be so great, that the advantages to be derived would be virtually absent. In the case of cycles and motor vehicles of that type, the pneumatic tyre is an undoubted advantage, for in one case it removes much of the vibration from the feet, which would be conducted to the body, and in the other it might be found difficult to introduce suitable springs on the ground of the weight or of expense.

The pneumatic axle is the true solution to the trouble, when a satisfactory one is made.

The horse is able to start a carriage by exerting his maximum power. He anchors his feet to the road, throwing forward and dropping the weight of his body. An engine, however, does not possess this property. An engine of any given horse-power has its capacity calculated for a given rate of speed. For instance, if a 6-brake horse-power motor is purchased with a normal speed of 300 revolutions per minute, it is understood that this brake-horse-power will only be given off when the speed in question is reached, at a given gaseous pressure in the cylinder. Conquently, when the crank, or its equivalent, is turning more slowly, 6 horse-power is no longer given off.

It is at the moment when the vehicle is to be started on the road that a larger horse-power is required, and it is at this time that the engine is incapable of giving it, unless it is run at a considerable speed first, and then geared to the carriage. This is a quality, and indeed a defect inherent to all the known oil and gas motors, where a clutch of some kind is necessary.

Great pains have been taken to achieve success in starting and stopping oil and other motors of this class placed on carriages, when passing through traffic, but even if this latter end were attained, nothing would have been gained, because of the time necessary for the motor to get up its speed before the carriage could start running afresh. It may, therefore, be concluded that until some further, and at present unknown improvement comes about, the oil motor will have to be kept running at all times during temporary stoppages, which, apart from other disadvantages, is very wasteful.

The electro-motor offers certain advantages, inasmuch that it is easy to stop and start, for accumulators possess a reserve power similar to the steam-engine, but at the risk of wearing the accumulator.

Of course, if larger electro-motors or other forms of engines were carried than are necessary, some of the difficulties pointed out would be greatly reduced; but practical considerations such as expense, great additional weight, bad economy in working, bar such a procedure.

With the steam-engine we have great reserve power. It is merely a question of raising the steam pressure by the application of more heat to the boiler, or of using the heat already given to the boiler in a more advantageous manner to obtain the additional power. It might be urged that a 4 horse-power steam-engine would not be strong enough to render 10 horse-power at any time, but by putting a few pounds extra weight into the working parts, there is no difficulty or danger in accomplishing this, though such an engine would not be suitable for running continuously at the higher power, on the ground of want of economy, as the boiler would be continually strained to its utmost, and this, although it might not be productive of danger, would be an unfair tax to place upon it, and would necessitate earlier renewal.

This is why the steam-engine when placed upon the road carriage can start and stop in the traffic with the same facility as the railway locomotive does with its train.

It has been urged by some leading engineers that the main success of the railways has been due, not to the locomotives, but to the nature of the road, and no doubt there is much truth in this, for plate-ways, granite-ways, and other tracks of a similar nature suitable for highway purposes have been proposed, and may in the future find still more favour. But it is hard to bring oneself to imagine that the ingenuity of man cannot modify the locomotive to suit the road when it has harnessed far more difficult problems.

Many devices have been put forward for constructing a road engine which shall lay its own rails as it proceeds. Some of the methods are very ingenious. In some cases planks or rails are laid and raised as the wheels pass along. In others, the wheels travel in a large circular ring. Patents for similar methods have been taken out over and over again, and it appears to me a disgrace that a Government Department should thus take money under false pretences.

All the advantages to be gained by the use of moveable rails or other equivalents can be obtained by modifications in the wheels without the auxiliary. At the same time there is much to be said in favour of some of the proposed schemes. I will give one or two instances.

If a combined locomotive and waggon is to be taken over a ploughed field to collect produce, the process might be impossible if the ground were soft. Yet if planks were laid along the route to be taken the difficulty would be overcome. The equivalent to this would be self-laid rails carried by the locomotive. Again, the wheels running within a large circle present the advantage to be gained by the use of very large wheels, which by any other method would be impracticable, so that a locomotive could proceed over very bad roads, which might otherwise not be possible without excessive engine power. It has become the habit to pooh-pooh these devices, but I think that there is more advantage to be gained from them than it is usual to give credit for, especially under certain given conditions.

I will now turn to steam-power on the highway. After a careful study of probably every self-propelled carriage which has been made from the earliest times to the present day, I have come to the conclusion that Hancock's disposition of the working parts cannot be improved upon. This was my opinion long ago, and I was pleased to find Sir Frederick Bramwell and others uphold the same view. I pointed this out to M. Serpollet, who, having examined the matter, is in full agreement, and his new carriages are being built on these lines. I regard this circumstance as a compliment to English engineering.

Of all motors for carriages at the present day, I hold that steam is by far the most suitable and advantageous for real work, and that when the Serpollet boiler or one of a similar type is employed, nothing more can be desired for many years to come.

Of English manufacturers already busy at work on steam road vehicles, Messrs. Philipson and Thornycroft may be reckoned amongst the leaders. The steam carriage which has been brought nearest to perfection at the present time, is that designed by M. Serpollet. I will, therefore, give a brief description of his vehicle with its most recent improvements. M. Serpollet has adopted the present type from the instructions I gave for the carriages constructing for me.

The engine and disposition of the parts are all simple matters not subject to patents and not capable of material improvement, as they have all been common knowledge for the past 70 or 80 years. The boiler and furnace alone have been the main difficulties in connection with the subject. Many waterless boilers appeared before M. Serpollet's time, but to him the credit is due for having devised a form of boiler, simple, cheap, and effective.

The principle of the Serpollet boiler is so well known that I need not enter into it again. It will only be necessary for me to describe the boiler and furnace in their most recent form. The earlier ones were not practical from an engineer's point of view: the furnace was large, a great weight of fuel was necessary, and fumes were produced.

The present boiler is made up of several tiers of crushed bent tubes, the steam space being horseshoe in section, and a petroleum furnace. The chief improvements consist in very materially strengthening the metal of the tubes, which gives the advantage of a reserve for storing heat, which is essential, as well as for durability's sake, and the method upon which the tubes are built up is far simpler, and renders repairs, when found necessary, rapid and easy to carry out. Those tubes which are nearest the fire are thicker than the elements more distant. In some forms, the tubes are further bent into spirals, thus giving additional strength and an increased heating surface.

The fire itself being a heavy oil petroleum furnace, offers lightness and security against breakdown and accident. A large reduction in weight, due to this form of furnace, gives an all-round advantage, especially now that the engines are constructed to condense.

The ton of fuel and water, which at one time it was necessary to carry, is now largely dispensed with, and, in consequence, the carriage does not require to be so strongly built. Ten hundredweight, at least, are saved in the weight of the carriage and furnace. In consequence, the older carriages, which weighed at least two tons when prepared for a long journey, could now be constructed to weigh 10 to 20 cwt. laden.

But as the carriages, at present being made, weigh nearly double the lower weight mentioned, it may be asked why should this be so?

The reply is, that there is a growing tendency among French manufacturers to build on English lines of solidity rather than of elegance and lightness, and a great deal more weight is being put in those portions where the strains come. Six cwt. is very soon accounted for when this is done, and in order to secure the convenience of a movable body, portions of the framework are duplicated, *i.e.*, the underframe must be there as usual, and the frame for the body must be a separate one, so that additional weight is found in this direction. The modern steam carriage weighs about 18 cwt., and is far more satisfactory than the old forms, and decidedly superior to any of the oil-driven motor carriages which have appeared before the public.

There are many points of importance in the construction not new in themselves in which strength and lightness are the main features obtained. The guiding bar does not act directly in steering operations, but by means of a multiplication wheel, for unless some method such as this is adopted there is a danger when meeting a large stone on the road, of overpowering the driver and throwing the carriage to one side when travelling at a fair speed. The multiplication arrangement gives better control to the driver, rendering such an accident impossible. Another way is to place the turning point of each wheel within or over the axle.

The body of the carriage, so far as the eye is concerned, appears as one. In reality it consists of three divisions—the conductor's seat, with a place beside him, in front; a boot at the back, similar to that of the phaeton, but no seat in it; and between the boot and the box seat the space is occupied by a victoria, brougham, van, or any other kind of body that may be desired, these bodies being removable without recourse to tools, and interchangeable at pleasure. The front can be covered by a glass cab to protect the driver and his companion from the weather. At the back of the boot are two doors: on opening the right-hand one, the boiler is seen, and the left-hand cupboard contains a vertical engine.

The engine is a double-tandem expansion type, and the reduction of speed as between the engine and driving-wheels is not great, this being effected by means of a specially-constructed strong single chain, situated midway between the right and left driving-wheels, just as Hancock placed it in his carriage. This chain is dispensed with in some cases, so that the driving is direct. The engine cranks, chain, and any other working parts are completely encased, so that no mud, dust, or wet can reach them. The engine is capable of giving off powers varying from 4 horse-power normal to 10 maximum. The boiler pressure can be raised to 16 or 17 atmospheres without danger.

Briefly, the following is a summary of the advantages presented by the new petroleum furnace:—(1) No smoke is produced when the burner is preparing to be lit; (2) very little methylated spirit is required for lighting; (3) when making a stoppage for a considerable time, such for instance as paying a call, the petroleum is cut off from the main burner, whilst the auxiliary burners keep the former hot for starting afresh; (4) the burner can also be cut off when descending a hill; (5) the expenditure of heavy petroleum, which can be obtained in this country at from 3d. to 4d. per gallon, would not, on the average, exceed in the case of a carriage such as described, 1½ gallons per hour when carrying four people at a speed of 12 miles an hour on average roads; (6) the weight of the carriage unladen will not be greater than one ton; (7) six minutes only are necessary to prepare the carriage for running, and being free from all complications, any intelligent man can drive it.

The natural question suggests itself, Should the boiler or burner wear out, how often is renewal necessary? In the case of the boiler, it is only the lowermost tube which requires occasional renewal, though of course in time the boiler will wear out. The present cost of this tube is about 30s., and perhaps once or twice a year it might be necessary to replace it, if the carriage is greatly used. The whole boiler is priced at the present time at £30, but the total renewal is necessary only after many years of wear. I should estimate that even with hard work, *i.e.*, working the boiler harder than is fair, the annual expense would be under £5. These boilers, when made in England, will undoubted be cheaper. The expense of renewing any part of the burner is exceedingly small; a few shillings would be the outside, and it would probably not be necessary to do this every year.

The repairs and expense of certain renewals in the case of petroleum-driven carriages is far greater than this, as all know who own these vehicles, so that steam possesses the advantage over all such motors, although I am ready to to admit that when a light, cheap, and lasting high-capacity accumulator makes its appearance, electricity will stand before steam for attention and comfort, if changing and charging stations exist throughout the country at easy distances.

There are several points in connection with steam carriages which cannot be over-rated, and are greatly to be appreciated, by those who have been in the habit of using petroleum-driven motors. The chief one is that the crawling process up a hill is dispensed with, and twelve miles an hour up the steepest hill which horses and carriages at present climb, can be obtained without an effort. Secondly, when stopping and starting in the traffic, the engine is stopped and started as would be done in the case of a horse. Since the whole of the steam is condensed, none of it passes into the atmosphere. Should by chance any do so, being superheated, no vapour escaping is visible, and days may go over before it becomes necessary to take in a fresh supply of water to make up for any slight waste there may be.

There are no valves to grind, no cylinders to clean, no inflammable material to store at home or carry when on a trip, no unpleasant smell is produced, there is absolute freedom from vibration, no chance of a breakdown when least expected, no accumulator to charge, or platinum points to be renewed, no ignition lamps and tubes requiring attention and occasional renewal, all repairs that may become necessary at any time, the carriage builder, or even the village smith, can carry out.

Quite apart from the advantages mentioned there is another which is of great practical importance; and is, that any moderately intelligent man, with a few hours' instruction, becomes master of the engine and carriage.

It is possible to find men who have been accustomed to steam-engines in large numbers. There ought, therefore, to be no difficulty in finding a supply of drivers in proportion to the demand. This is not the case with oil-driven vehicles, on account of the complexity of the working parts, combined with a quality unknown to the steam-engine—that of developing some new defect when least expected.

All motors may be divided into balanced and unbalanced sections. By "balanced," I do not refer to the parts of the machine being duly poised, such, for instance, as additional weight placed on some part of the fly wheel, to balance the weight of the crank and any rods on the opposite side. I use the expression in regard to the primary force. For instance, we all know that in the gas-engine the running is spasmodic, and can only be overcome by the use of enormously heavy fly wheels, so heavy indeed that, in practice, a certain amount of jerkiness is preferred.

All oil motors are gas-engines, and nothing more and nothing less. They may therefore all be classed under the one head. Steam and compressed air motors come under another category. It is well to point out the difference between the two classes of engines. With the gas-engine, the pressure starts at a maximum and falls. With steam and compressed air, the pressure may rise gradually to a maximum, and then fall. This is why steam and compressed air motors run so smoothly.

It may be contended that the same result could be obtained in the case of the gas-engine, by using a separate vessel to explode the gas in, and then admit such gases into the cylinder, under steam-engine conditions. Many years ago, I made a large number of experiments in the hope of obtaining success in this direction, and many others have done the same. Although the results are successful in one sense, it is at the expense of efficiency and extra weight.

There is a method of obtaining smooth motion from gas and oil motors, by counterbalancing the explosion. Many such engines have been constructed, and consist as a rule of two cylinders in each of which there are two pistons moving away and towards each other.

Complete success can be obtained by this means, but only by the introduction of great complication in valves and gear, so that in practice it is probably more convenient to be subject to vibration in an oil or gas motor carriage when running at low speeds, than to incur the risk of difficulties which must arise with still more complex machinery. When oil motor carriages are running at a moderate speed the vehicle becomes the flywheel, and the greater part of the vibration disappears, but there is no means of obtaining regular and steady motion at low speeds, however good the governor may be. There will always be a tendency for the engine, when the full power is not necessary, to run faster than the governor allows, and the speed is arrested. This action keeps on repeating itself, consequently the carriage advances by fits and starts. The oil motor carriage is only comparable with the horse-drawn vehicle for comfort when running at high speeds. With steam, compressed air and electricity, these disadvantages are completely absent, likewise the necessity of a clutch, or its equivalent.

I have made some experiments with my oil motor carriage on roads covered with snow and ice. It is known that many possessed of such carriages have traversed portions of Switzerland and elsewhere covered with snow. I am ready to admit that such carriages lightly laden, travel well over snow, but after a thaw, succeeded by a frost, hill climbing becomes a dangerous proceeding. I have found on several occasions, although the motrice wheels were revolving, the carriage bodily slipped backwards, and naturally no brakes are of any avail under such conditions. I took the safest course at such times, and turned the carriage gently into the hedge and waited for help, or procured sand to get a grip on the road. It is evident also, under such conditions, the power of the engine is not a factor in the case.

I would strongly recommend possessors of these carriages to supply themselves with an ice brake, similar to that which I have put on my own carriage. It consists of two rods of iron with prongs at the free ends, the other ends of the rods being hinged to the carriage. When mounting a hill covered with ice the rods are lowered to the ground, and if by chance the carriage cannot advance the spikes at the free ends of the rods stick into the ground and prevent an accident. This brake is inclined at an angle of 45 degrees to the road when resting on the ground. Ice wheels may also be required in some climates.

A few words may now be said in regard to carriages driven by electric energy. It may be desirable to point out why electricity is not in the competition at the present time, except to a very limited degree so far as independent traction is concerned.

The only known practical method now for storing electricity is by means of batteries, either primary or secondary. The primary batteries are too troublesome and expensive in the present state of knowledge to call for any remarks. The secondary battery is either too heavy, and if light, too costly for repair, to be regarded otherwise than as a luxury.

It is claimed by some makers that the vibration to which they would be subjected, both in the case of the heavy and the light type, does no harm and the maintenance is greatly reduced. I have no desire to let it be thought that all these statements are false, but I would point out that there is absolutely no evidence to bear out such assertions. All the evidence of the past is against the probability of such statements being fulfilled, and no new discovery has come to light to reverse past experience. Moreover, the only proof which can be brought forward contains the factor of time, and this has been so far impossible on account of the supposed improvements being very recent.

It is only fair to state that some of the accumulators, which have appeared of late, are more suitable for traction than the earlier ones. The modifications consist in using celluloid pots, which are lighter than glass, transparent, and not brittle. These pots can be closed effectually. The plates in the sections are made thinner, and in some cases wrapped round with perforated celluloid, the intention being to prevent posible contact between plate and plate.

The most promising separator is the material devised by Mr. Joseph Swan. It is like cotton wool in appearance, though in reality celluloid. This "wool" is packed between the plates and around the section, converting the cel into practically a dry one.

Notwithstanding these improvements, there is yet an element of possibility that the maintenance will work out higher than is anticipated, but at any rate, the mechanical advances referred to have greatly improved matters, although the electrical properties and efficiency remain much the same.

But to leave the subject of maintenance ou of the question, the light accumulator is ver heavy, and the losses for any type cannot b estimated at less than 20 per cent., and i practice 30 per cent. is much nearer the truth Hence it would be unfair, from a commercia point of view, to regard the cost of the energ otherwise than one-third more than that a which it can be produced.

There would be few who will disagree wit me, when I state that a very fair price for th electric energy per unit is 3d. Although I d not contend that under exceptional condition it cannot be produced for less, yet the figur given is by no means an unreasonable one from the extensive knowledge we have of th cost of the production of electric energy a lighting-power stations throughout the kingdom. Consequently, if the electric energy i to be carried, about 4d. per unit is a fair estimate of the cost when used on a movin vehicle.

Roughly speaking, three-fourths of a unit i a theoretical horse-power. In practice, unles the motor is very large, say exceeding 6 horsepower, one unit per horse-power is the approximate expenditure per hour. No doubt man will say that this is excessive for a carriag carrying a 6 horse-power motor, capable a times of giving off a larger power, but I woul point out that when the roughness of the road comes to be considered, and the stops an starts necessary when approaching and running through towns, my estimate is an exceedingly fair one.

To sum this up, I contend that as matter stand to-day, it is impossible to reckon th power delivered in an electric carriage at les than 4d. per horse-power per hour, which, c ourse, is enormous when it is further conidered that maintenance has not been taken nto consideration at all, and that only a short listance can be run before the accumulators nust be re-charged, and that unless charging tations are to be found throughout the locality vhere such carriages run, a useless mileage nust be added for getting the vehicles to the harging station and back to the points where hey have to be used.

Now compare these conditions with those of enzine and steam carriages. The cost of enzine gas may be roughly taken as equal to oal gas at 3s. 6d. per 1,000 cubic feet. Hence gas motor using benzine, works out nearly ne-fourth of electric energy.

In the case of steam, using petroleum for he furnace at, say, 6d. per gallon (in large uantities, however, it can be purchased at bout half this price), the cost per horse-power er hour would not differ materially from the ost of the benzine motor, and, consequently, ar cheaper than electric energy. In steam-ngines using coal or coke, taking the price of uel at £1 per ton, and the consumption at 2 lbs. of fuel per horse-power per hour, the ost is about the same as crude petroleum.

It has, however, been found in the case of ocomotive engines that the petroleum fire is early double the price of a coal one. In this ase it must be remembered that coal, say at 2s. per ton, can be obtained for road traction, he working cost is still further diminished. ractically, benzine and steam come out four mes cheaper than electric energy. All these acts should be borne in mind by those who hink of embarking money in electrically proelled vehicles.

In round figures the efficiency of a good team-engine may be taken at 10 per cent., ut for a road carriage this would probably ot be better than from 5 to 7 per cent. A as-engine, whether using coal, benzine, or as, has an efficiency of about 25 per cent. lectro motors have a commercial efficiency f from 80 to 85 per cent., but in this latter ase so many conversions of energy are ade between the coal and the electro motor, hat the actual efficiency is very low indeed.

I have always held the view that a perfect ccumulator will not appear until the disovery of some new and cheap metal, ot that the ideal accumulator cannot be oduced to-day, but only at forbidding pense. At the same time discovery may ad to the production of a battery of some pe quite different to that to which we are at present accustomed, depending possibly on some new principle.

It must not be thought from the various remarks I have made on the value of electrically-driven vehicles, that necessarily they have no future as matters stand. My remarks apply to those instances where the carriages are to be used commercially to obtain a good money return. Omnibus horses have to earn a certain amount per day. But this is not the case with a pleasure horse, or with an animal kept by a professional man. In such instances the maximum commercial output of the horse is not sought for, and under these conditions electric energy may do very well, provided that the following conditions can be obtained:—

1. A guarantee from a company to keep the accumulator in order.

2. That conveniences for recharging the accumulator exist.

3. That the distance to be travelled in one day shall not utilise more than the electric energy stored at one charging.

M. Jeantaut was one of the first in France to make an electric carriage, though many had been constructed in England previously.

M. Duracq's carriage, which was shown at the Salon de Cycle in December, 1896, is undoubtedly the best carriage of the kind which has yet appeared. I have had the opportunity of examining the vehicle closely, as well as riding in it, and it is admirably adapted for town use.

M. Duracq, in a pamphlet, gives calculations to show that electric energy is cheaper than living horse-power. The whole of his estimates and allowances are faultless, but an error creeps in, according to my mind, at the start, where he assumes to small a power to pull one ton at eight miles per hour along a road. The figure he gives may be true on a level asphalte road, but my experience, verified by that of others, would go to show that at least three times the power allowed is required in practice, taking roads as we find them. Neither is any allowance made for restarting after stoppages, when considerably more current is necessary, and since an electric carriage is more likely to be used in towns than elsewhere, such stoppages in the traffic will be frequent.

If these various points are taken into consideration, instead of electric traction coming out, as M. Duracq makes it, 40 per cent. less than horse traction, it will be found to be very much greater.

In order that there shall be no misunderstanding I will quote the figures upon which the calculations are based. M. Duracq takes a well suspended carriage, and estimates 35 kilogrammetres per ton for speeds varying from 12 to 15 kilometres the hour. In English this means less than ½ horse-power to do the work named, and all those who have experimented with self-propelled vehicles know that this is much too small an allowance, except under the most favourable conditions.

I will now turn to the question of the power of the engines to be placed upon motor vehicles.

It cannot be too strongly impressed upon those who intend to take advantage of this class of traffic that the following conditions are essential for success:—

1. That whatever is the proposed speed decided upon, it should be calculated upon the assumption of being an average speed, whether the country be level or hilly and the roads good or bad. Climatic changes must also be taken into consideration. Thus, if for a light vehicle, weighing when laden, say one ton, twelve miles per hour has been fixed upon for the speed, then the power carried should be sufficient to run at this rate in all weathers and over all highways, and to climb every hill with a maximum ascent of, say one in ten, at the proposed rate. The vehicle should also be able to mount a hill of one in five, but at a less speed.

2. That the mechanical construction shall be such that any intelligent man after a few hours' practice shall be able to manage it.

3. That there shall be nothing about the carriage likely to prove a danger to the occupants, or the general public.

4. That the vehicle shall be strongly made, and no part likely to wear out quickly.

5. That dangerous fluids and fuels be excluded as far as possible.

6. That the construction be such, that when repairs become necessary, they can be carried out either temporarily or finally, by any intelligent village smith.

In respect to the above considerations, there is only one which needs special comment. It is evident that the power required to obtain a given speed on the level and down-hill, needs no consideration, for if the engine is strong enough to mount hills of one in ten, ample power exists to do the rest.

I have come to the conclusion from experiments, and practice, that for every ton, not less than 10 horse-power should be carried. This does not necessarily imply that a 1 horse-power engine is required. It means that the engine shall for considerable periods and without injury to itself, be able to give of 10 horse-power. It must be remembered tha when the carriage is started, a far large amount of power is necessary than when it i running. It is, therefore, very important t have a good reserve.

I have examined with close attention probably by far the greater majority of th benzine motor carriages in existence, and hav ridden in a large number of them. I think i is quite unnecessary to give scientific evidenc to disprove the various clap-trap which ha been put before the public by company-mongers, in the hope of drawing money Statements as to 60 miles per hour, and variety of other nonsense, needs no comment Anyone present is capable of running carriage strongly made, at 60 miles per hour without a motor, and without a horse, b merely starting the vehicle down a long stee hill! In fact, all statements as to speed, i connection with motor carriages, are wort nothing.

There is no difficulty in obtaining enormou speeds with very small power, under favourable conditions. The real test is: Will th vehicle mount a hill, say one in ten, when th thermometer is 90° in the shade, for a distanc of five miles, at the respectable speed twelve miles per hour. Any test short of thi supposing this speed is desired, should end i a decision to reject the vehicle as unpractic and probably worthless.

You must not understand that I necessari fix twelve miles for the rate, for many wou be content with a lesser speed; and for hau age where vans and similar vehicles a employed, five or six miles per hour would deemed sufficient on steep hills.

It may prove of interest to give a fe statistics, calculated by some of our greate engineers. They were compiled with referen to haulage on roads in general, and t figures must not be accepted for self-propell vehicles, for the many reasons already referr to, the chief one being that when the moti power is self-contained, the haulage fact must be multiplied two, three, or four time according to circumstances, but the Tabl will hold good for self-propelled traffic wh the factors are multiplied by a constant.

Experiments made by Telford showed th draught for a wagon weighing about 21 cw was as follows:—

	lbs.
On well-made pavement	33
On broken stone surface on old flint road	65
On a gravel road	147
On broken stone road on a rough pavement foundation	46
On broken stone surface upon a bottoming of concrete formed of Parker's cement and gravel	46

Babbage has stated that the friction or esistance of roads are as follows:—Well-aved roads, 1-77th part of load; gravel road, -35th; fresh earth, 1-16th.

By his experiments the following results vere obtained:—Loose sand, 1-4th part of oad; fresh earth, 1-8th; bye roads, 1-9th to -10th; dry meadow, 1-25th; dry high road, -40th; hard macadam, 1-33rd.

Telford's Tables gives in round numbers as he difference between the lowest and greatest igures, a proportion roughly of one to four-and-a-half. Babbage's Table for equivalent oads by theory gives the ratio roughly one to wo, and by comparison, taking hard macadam and a bye road as an equivalent comparison, the ratio is one to three. Striking a general average, it may be assumed that the power required to draw a vehicle over a good evel road, as compared with a level rough oad, would be four times greater in the latter han in the former case.

Here is another Table of considerable nterest which deals with a stage coach. It may be observed how very close the figures are to those I gave in an article published some time since in the *Engineer*, although I had not seen the statistics in regard to the stage coach at that time.

With a stage coach weighing 18 cwt., exclusive of seven passengers, the following were the results:—

Rate of Inclination.	Rates of Travelling. Miles per hour.	Force Required. lbs.
1 in 20	6	268
1 ,, 26	6	213
1 ,, 30	6	165
1 ,, 40	6	160
1 ,, 600	6	111
1 ,, 20	8	296
1 ,, 26	8	219
1 ,, 30	8	196
1 ,, 40	8	166
1 ,, 600	8	120
1 ,, 20	10	318
1 ,, 26	10	225
1 ,, 30	10	200
1 ,, 40	10	172
1 ,, 600	10	128

The following experiments may also be given as affording some further idea of the power required for haulage:—

An engine drawing 18 tons on a fairly level road. Separate locomotive 18 tons, when charged with fuel and water, must give indicated horse-power of 30 to reach speed of four or five miles an hour.

Another engine, 12 tons, drawing 25 tons load, for same speed, 40 horse-power.

Another engine, 15 tons, drawing 32 tons, same speed, 50 horse-power. [See *Fletcher*.]

Although the question of rapid mechanical traction has come to the fore after a lapse of about half-a-century, it cannot be said that the interregnum has been due to any failure in regard to this mode of traffic. It is right to point this out, because the French and Germans claim to have revived this class of traffic, and that it had never been done before with success. The French also claim that the first self-propelled vehicle was made in France, by Cugnot. The latter point may be conceded, but I claim that the English nation where the first to make really practical road carriages, as they were the first to construct railways, and that the early motor traffic of the period, about 1830, was killed, partly by the attention drawn to railways, but in a large measure by the monstrous Acts which were passed, dealing with the tolls to be imposed on them when travelling on the turnpike roads, and although these Acts were modified at a later date, the definition of a locomotive, as laid down in the Act of 1865, finally stopped the way until the passing of the Act of last year.

I have no hesitation whatever in saying that the steam coaches of Hancock, and of many other former designers, could be run to-day with perfect success, and that the only improvements we can now add to their designs are due to the better and cheaper material we have at our disposal. That this view is reasonable let me give you the parallel. Compare the locomotive of to-day with that of 1830. The improvements are those simply due to the increased demands placed upon the railway system. The general principles and design remain the same. It is mainly in detail and size that the alterations are to be found.

To expect, as some people do, an extraordinary invention will sooner or later appear to render motor traffic on the highway a success, is simply ridiculous. Not that wonderful discoveries may not be made, but I think that all engineers will agree with me that at he present time we have everything at our command to make this class of traffic all that is to be desired. The only thing now wanting is practice, with the relegation to the background of the company promoter.

Our great manufacturers are perfectly competent to deal with the question, and it will be these firms which will not only survive but will also bring the whole matter to a happy issue, in conjunction with such factories as may come into existence, placed upon an honest commercial basis; and as already stated, I do not believe there is any chance, as matters stand to-day, of benzine, oil, gas, or electricity competing with steam, where real work is to be done with certainty.

I should like to refer to the evidence given before the Parliamentary Committee of 1831. Telford, Gurney, Macadam and others were witnesses. They appear to have agreed in regard to two points, viz., that the wear from the horse shoes was greater than that from the carriage wheels, and they also expressed the opinion that there should be one inch width in the tyre for every ton carried, inclusive of the weight of the carriage. Of course we know the roads of to-day are not made in the same manner as they were at that date. I believe that our roads have been greatly improved since that time.

My observations do not bear out the two points mentioned. I do not think that the general law of one inch width of type per ton must necessarily be followed up the scale. A proper width of tyre for a carriage weighing one ton, I think should be two inches instead of one inch; then add one inch for every ton up to say three tons. At this the tyre would stand at four inches, and on high roads this is ample width for very much heavier weights.

Then again in regard to the wear and tear due to horses' feet, I believe that the wheels do far more mischief, particularly in the case of a narrow road, as it will always be found that the ruts are the worst portion of the road, and not where the horses tread. Even on wide roads the wear of the wheels appears to do the mischief. I am quite ready to take a different view if the road is practically perfection and "quartering" is constantly taking place. Then the wheels will wear the road very equally.

The remainder of the evidence before the Committee tended to show that steam carriages were at that period a success and likely to continue so.

I cannot refrain from pointing out a possible mode of traction, which appears to have been completely neglected. When the construction of railways was on the *tapis*, great opposition was offered to their construction, on the ground that England was well served with canals, and that the companies, owning these, would be greatly injured if the railways were made. I have, in my possession, copies of some remarkable letters which appeared early in the century on this subject.

I have not the least hesitation in saying that if electric traction could be applied to the existing canals, they would be made far more useful, as well as more profitable to their owners. Electric traction could be applied in this case at a comparatively small expense, and it would be worth while to have an experiment made on an extensive scale.

For light traffic on railways, the self-propelled vehicle has a fair opening; and abroad, experiments are being made in this direction. One or more railways in Germany are making trials, also the Northern and other railways in France. For compulsory service, as in the case of postal mails, and for lightly laden night trains, the French Serpollet Company have constructed carriages to carry from forty to fifty people, with a sufficient engine-power to run at about thirty miles an hour for such purposes. It is estimated that the cost of running these compound carriages is about one-third the cost of an ordinary train, and the wear and tear to the permanent way is far less. On almost every railway system in England there must be an opening for this class of traffic. It may also be mentioned that these French steam carriages are capable of drawing one or two ordinary railway carriages, but at a reduced speed, say at 18 to 20 miles an hour.

Without doubt, a great many people are puzzled why self-propelled traffic has again come to the fore. In England this traffic has been going on unostentatiously for years, traction engines being largely in use, but their speed is so limited by law, and they are so surrounded by legal technicalities, such as a license necessary in every county, and taxed, that no advance could be made in the direction of light traffic. In residential districts, these restrictions have proved a blessing.

In France and Germany, although there are laws affecting self-propelled traffic, they are far more lenient.

The great success which cycling had in France, following upon the prize given by *Le Petit Journal*, which also gave so large an advertisement to that newspaper, led to the energetic proprietors offering a prize for quick self-propelled carriages, with the result which s so well-known.

Consequently, the revival is not due to any new discovery or special invention, but simply hat many minds were turned to the subject in he hope of gaining the large money prize. The French nation, possessed of a character highly enthusiastic, always goes to extremes. A perfect rage set in for the class of vehicle under consideration, and those who became possessed of these carriages, being wealthy, gave a great impetus to manufacturers. You have here in a nutshell, the whole history of he revival of self-propelled traffic of the ighter kind.

A great deal of agitation took place last year to obtain a satisfactory Act of Parliament, to enable the same freedom to be given n England as abroad for the use of motor vehicles on highways. It was generally expected that as soon as Englishmen obtained his freedom, a great nuisance would be produced by the presence of vast numbers of motor carriages in the streets of towns. I never took this view myself, but always thought hat the change would come slowly but surely.

There is no doubt that the position taken up by certain of the motor companies has, for he moment, created a lull. Nobody, when purchasing a carriage, desires to buy a legal action at the same time.

Tremendous opportunity is therefore offered for honest commercial companies to start at he present time, and I find that this fact is well appreciated in financial and commercial circles.

The Society of Arts may be said to deal more largely with commercial interests than with any other. It has taken part in many of he great movements during the Victorian era, which have so materially increased the wealth of this country. I therefore feel that it is not altogether out of place to say a few words in regard to patents, so far as they touch this particular question under consideration, as well as on patents generally, as they affect he manufacturer and the public.

The present hesitation to take full advantage of the Locomotives on the Highway Act, 1896, s due in a large measure to the blemishes existing in our Patent-law, which enables any set of people to bully or blackmail, not by right, but by might, the assumption being that he threatened parties will not fight.

In dealing with the question of patents, it s not my wish to deliver a legal discourse upon the subject, and the numerous "ifs" and "provided" are omitted. My object is to give you a general view rather than a complete technical analysis of the subject.

There is too much tendency in the present day to patent an article in the hope of it accomplishing something for which it was not intended.

There is no doubt that our Patent-law does a good deal to prevent useful inventions being made in regard to any particular matter where a number of patents already exist. No man will turn his attention seriously to develop a piece of machinery when he thinks he may be stopped from reaping the harvest he may deserve by finding that in some little detail a patent has already been taken out. That my view is correct is corroborated by manufacturers on all sides. It may be contended that the present law would permit him, notwithstanding, to work his invention, and no doubt this contention is true if the inventor can afford to enrich a number of lawyers first and hand his profits over to others. It is not the question of patents which I attack, but the method by which they are worked, and a great improvement could be made in this respect. Much of the advance which has taken place in foreign countries to out disadvantage has, I think, been due to defects in our Patent-law.

Our Patent-law is evidently unsatisfactory. How could it be otherwise expected when the principle by which our Governments work is to deal with these matters in a kind of political way, and place men in charge of the work who, as a rule, know nothing about the special subject they have in hand? I could give innumerable instances of this process, but to do so would open me to the charge of personalities, which I am anxious to avoid, because I know well that those who carried out the work did so under instructions, and to the best of their ability, often limited.

All practical men will recognise that no patent in England is of value until there have been decisions in the Law Courts in regard to infringements, and that if a defendant instead of fighting gives way, and perhaps pays agreed damages, the patent stands exactly where it did before the action arose, since it has not been upheld nor has it been overthrown. Again, if a good fight is made and the defendant loses, there is nothing to prevent another infringer being proceeded against, and he might be more successful in the action and overthrow the patent. Then there follows another injustice, that the first defendant who lost his case obtains no relief, although the patent has been declared invalid subsequently.

Any article which is patented in England cannot be brought from abroad except under two conditions; firstly, that the individual doing this is willing to pay what may prove to be blackmail to the holder of the English rights, or to submit to an action with the possibility of losing his case. The patented article moreover is liable to confiscation without claim for damages. This state of things, although it exists in many other countries, is eminently unjust and against the interests of the nation.

I will give two instances bearing upon what I have said to show how unfair things are at present. A few years ago I took out a provisional specification for an improvement in keys. It was brought to my notice about a week or a fortnight later that another provisional specification had been lodged identical in character. Indeed I learnt the circumstance by pure accident. The question to decide was whether I had been anticipated or not. If so, it was not my intention to proceed any further. I then found that my specification had been lodged a few days—not a week—earlier than the other one, which had been entered in the name of some one living at Norwich, and a stranger to myself. Here was a case of two persons hitting upon the same idea practically at the same time, and each applying for a provisional specification, which was granted to each within a week. The sole difference between the two specifications was that the Norwich application included watch keys, and this was covered in mine by using words to the effect that the improvement was to apply to every form of key, for whatever purpose it might be used. According to common sense and equity the Norwich man ought to have had his money returned, which of course was not done.

A second instance is the following. A desire was expressed to me by a gentleman living in France to give him all the information I could to render agreeable a proposed trip in England to be made in his horseless carriage. I wrote to him to say that if his carriage came under certain patents it might possibly be confiscated if it came to the knowledge of the owners of the English rights. Failing this, he might have to fight the matter out in the Law Courts, and as neither of these conditions were likely to render his journey to England pleasant, he had better ascertain from the makers whether anything about his carriage was patented England, and if so, whether the rights we held in this country by hostile persons, ar further to request the manufacturer to mal arrangements for him with any holder English rights to permit the carriage to ent without molestation.

It appears to me that, apart from the larg question, the following amendments should made without delay in the Patent-law :—

1. If it can be shown by the applicant f a provisional specification or patent, with twelve months from the date of first payir the fees, he has been anticipated, the fees sh be returned, provided he can show that the time of application he was ignorant of t anticipation.

2. That if in any action, a patent is declar invalid in consequence of anticipation by t issue of prior patent, the fees shall be returne With the same proviso as in No. 1.

3. That a patent shall become void, unle the present holder be registered.

4. That English patented articles may imported into England on the following co ditions : That the individual so importing giv notice to the Patent-office, or some oth selected Government department, of his inte tion to do so, with a declaration that t article imported is for his private use, and th he shall deposit a sum equal to 10 per cent. the cost of the article, which will be hand over by the Government department to t holders of the patent rights, and that t owner shall not be precluded from selling t patented article, provided he does not impo more than two in a given year, there being *bona-fide* understanding that the importatio have not been made with a view of trading.

5. That if a patented article enter the cou try for a short period with no intention trading, providing it does not remain mo than one year in England, the sum paid sh be one instead of 10 per cent.

6. That in no case shall a patented artic be liable to confiscation, but the aggriev party may have the power of applying to t selected Government department who shall a certain whether more than 10 per cent. shall regarded as the fair compensation, the costs be apportioned according to circumstances.

7. That patented articles may be made any manufacturer with the same freedom as they were not subject to rights, provided th the manufacturer declare to the select Government department his intention manufacture, and that department shall e

ire whether a royalty of 10 per cent. paid to holders of the right is deemed to be suffi- nt, and that the department shall not take o consideration the amount of capital which holders of the patent may have invested in watered their business, but determine the estion simply on commercial principles. is condition may be said to exist now, but h insufficient freedom.

3. That a patented article in the *bona-fide* ssession of a member of the public, *i.e.*, vate person, shall not be confiscated under y conditions whatever, but in the event of patentee gaining an action, the damages ll be paid by the manufacturer, and if the ods are foreign the private individual may called upon to pay 10 per cent. of the value the article, unless he desires to defend an ion with a view to upset the patent, in which nt, if he loses, he shall be liable only for costs beyond the 10 per cent. mentioned.

). That no back royalties extending beyond months shall be claimed.

The above amendments are greatly needed, d if they could be obtained with possibly tain variations, considerable impetus would given to British trade, apart from benefit to lividuals of the general public.

t often occurs that a good invention is held parties who are incapable or unwilling to nufacture, thus establishing the position of g in the manger simply to levy blackmail. new manufacture which might employ many nds, and bring capital into the country, is pped for a number of years, and perhaps ever if the invention or inventions in ques- n have been superseded before the expiry of patents.

t is well known that many inventors of a type take out patent after patent in regard various matters, few of which are really ginal; but the process is carried on in the pe that someone will be caught, sooner or er, in the net. It is a means of speculation st disadvantageous to the industry of this intry.

t must be evident that no inventor can sit wn and solve problems with a pile of patent cifications at his side for continual refer- e. No man could produce useful work by h a process. It is therefore obvious that entors should receive the greatest freedom, ich can only be attained if patents are not inted for trifles according to the present tem, and only after some kind of reason- e investigation.

he present Government would do much good if they would look into a matter of this kind, which is affecting the employment of the working classes in a large degree, as well as the introduction of those economies which save the nation money. With a better Patent-law, opening for the employment of capital at home would be extended.

Such subjects, which Ministers probably consider trivial, have a more far-reaching effect than the passing of Party legislation, or a variety of other measures before the House, in which a twelvemonth's delay would add to the peace of all parties. The Patent-laws can be made a blessing to the inventor and the public, or the reverse, according to their nature; and those of England partake rather of the latter character.

At Liverpool, I used the following words:—"One opinion from which I have never swerved upon this question is that no patent connected with self-propelled traffic is worth the paper it is written upon, whether the patents will bear the test of the Law Courts or not."

The above remark was very rightly made use of by the majority of the newspapers when criticising the various companies which had been formed, and were being formed about that period, and I was led to understand that those connected with the companies in question complained grievously of what I had said, it being contended by some of them that they held master patents and monopolies.

I think it therefore right to say something more upon this question, for to set up such untenable claims is unfair to the English manufacturer and to the English public. I intend, with your permission, to examine the whole question of patents more narrowly than I have done, and to prove that there is no master patent or monopoly whatever, which can apply to the construction of motor carriages generally, whether they be driven by steam, oil, or electro-motors.

I will not ask anyone to go further than to consult a book published by the Patent-office, and which may be purchased for a shilling from any bookseller by giving the order. This book is the Abridgements of Specifications, Class 7, Oil and Gas-engines, period 1877-83. Here will be found patents connected with the subject, all of which have now lapsed. There are other volumes of abridgements dealing with velocipedes, and with other matters, which also bear upon the subject, but the book mentioned is sufficient for the purpose, while if every detail is sought for, the original specifications can be consulted as well.

I will first examine whether any claim can be made for a master patent, in regard to motor vehicles. The possession of a master patent would mean a monopoly on the part of those holding the rights.

Let us see what a master patent means. Without entering into technicalities, it must be a "manufacture, useful, novel, and ingenious." Consequently, if the patent is a master one, this useful, novel, and ingenious manufacture can only and solely be made under the patent specification, or may be, under a group of such patent specifications. The patent might, in certain cases, be the embodying of some new idea of great value and novelty.

To explain more clearly, I will take the well-known case of the Edison-Swan electric incandescent lamp. Quite apart from the morality of the case, we find a master patent (or rather group of patents), *i.e.*, a lamp of special form suitable for a definite purpose, which can practically be made in only one manner for commercial success. These patents are of the class termed a combination, which means a combination of old things to form a novel, ingenious, and useful new one.

Incandescent lamps can be made in other ways it is true, but they have not the same value commercially. Hence the only lamp of practical value was covered by the patents, and was of a particular type, viz., a high resistance carbon filament in a practical vacuum, enclosed within a case of glass, hermetically sealed, with platinum leads passing through the glass, and the filament strengthened by the process of flashing.

Here we find a combination which has not been improved upon to the present day.

In the history of the world there has occasionally appeared a master patent, but these are comparatively rare, and always for some entirely new invention or discovery,

We will now examine whether it is possible for such a patent to exist for motor traffic in the present state of things. The only possible master patents which could exist, would be of the following nature:—(1) The combination of a motor, other than steam, with a carriage suitable to run on highways; (2) combination by which gas in the cylinder of a gas-engine can be ignited at any suitable time by means of an electric spark; (3) the use of a carburetter, when the gas is produced from an oil or spirit; (4) the use of a silencer for the exhaust in the case of gas-engines, when applied to a road carriage; (5) the existence of a gearing which is only and solely suitable for light traffic; (6) the use of a clutch in connection with light traffic.

This list is sufficient without dealing with other points which have virtually no importance. In the majority of cases no distinction is drawn between the gas-engine, oil-engine and benzine-engine, since the word gas covers gas produced from any material suitable fo the engine in question.

But, suppose a judge who was not a technical man were to hold a different view. Ther his attention would be called to a list o patents dealing with engines which use gas, produced from coal gas, oil and ben zine, all of which have expired, so tha no claim whatever could be made by an living man of rights connected with coal, gas oil, or benzine engines of an exclusive cha racter. Further, if a judge were to hold tha a combination of an oil-engine with a carriag was "useful, novel and ingenious," he woul again be confronted with several old patent which have expired, in which this combinatio was claimed.

The same remarks apply to the whole list various possible claims which I have enumer ated above. Patents have been taken ou more than fourteen years ago for oil-moto tricycles and bicycles, for electric ignition, f ignition tubes, for clutches, and as for gearin we all know that there cannot be an exclusiv right, as various forms have been used i connection with road traffic since the earl part of the century.

It may be inferred from these remarks th no patent taken out in connection with mot traffic is valid, but this I do not say. Som special device for doing a particular work ma be a valid patent, but it will not be a mast patent, and therefore will not prevent anyo else doing the same work by a modifi device.

To show you more clearly what I mean, will analyse a de Dion and Bouton tricycle. will not say that there may not be some par in the tricycle which are patentable, but these were upheld it would not prevent anyo else making a motor tricycle, leaving out t patented portion. The motor itself, as far I can see, has nothing novel about it. I success depends on good manufacture. there was any point in this motor upon whi a valid patent could exist, a motor could made just as good leaving this point out. T electric ignition has nothing particular abo to commend itself, although it is said that rrent is saved by the method adopted. It is old laboratory device, namely, a tetanus ring set in motion by a rotating cam, which as "common knowledge" when the patent as granted; but from an electrician's point view there are far better ways of achieving e same result, supposing it to be held that e ignition device is a good subject for a tent, and these are open to all.

To sum this up, an equally good tricycle can made to do all which the one in question ll do, without being subject to patents. The ccess of the tricycle in question is unquesnably due to excellence of manufacture, and t to any novel invention.

I will not weary you by going through all e types of carriages, whether driven by eam, oil, compressed gas, compressed air, electric energy, but I could prove with the eatest ease that the same remarks which I ve made in regard to the tricycle hold ually good as regards other types, and conquently there is no such thing as a master tent for motor traffic, nor can anyone claim monopoly in this respect.

At the present juncture a few words of advice existing or intending manufacturers of motor rriages will no doubt be acceptable, when ered by one who stands in a completely inpendent position.

When a manufacturer is threatened with an tion for infringement, if he desires to conue to manufacture and place upon the rket the article complained of, there are proverbial three courses open to him—(1) knock under and make terms; (2) to conue to take no notice, and risk an action; (3) take steps to compel the patentees to start action first, and oblige the threatening ties to prove their case.

strongly advise the latter course to be lowed in every instance, and the method of cedure which I would recommend is the lowing. When a manufacturer has the ghtest doubt as to his position, he should ke one of the articles stated to be an ingement, and place it on the market, then e notice of the fact to the parties who claim rights, and demand a reply within seven s. The reply must definitely state the ention to commence an action for infringnt, or some equivalent form of proceeding. ot, it is evident that the parties claiming not intend to face the Courts. If the answer es the form of a threat, and no further ion is taken, then the manufacturer should start an action on his own account to compel the parties to go into Court.

It is a very simple matter to prove or disprove whether the device, which have been made, is an infringement or not. There is a general idea that an enormous expense attends these matters. This is quite unnecessary. There is no doubt a Judge is very apt to look upon any mechanical device with a certain amount of awe, because he is not a technical man, and probably has admiration for what he thinks is ingenious.

The manufacturer, therefore, should ask for a technical assessor to sit with the Judge. A technical man is hardheaded, and will, probably, see no particular virtue in a device which is common place, and unworthy of a patent. The assessor has not to be paid for by the contending parties.

If it is then decided that the device in question is not the same, nor a colourable imitation of the article claimed to have been infringed, or that the patent is not valid, then the manufacturer is free, and may continue to manufacture without risk.

If, on the other hand, the decision is in the contrary sense, it is open to the manufacturer to make terms, or, which might prove the better course, to use a device outside the patent which would be more modern. This could only be done if the patent upheld were not a master patent, and such cannot exist in connection with motor traffic.

In fact, any manufacturer with £100 at his command can thus protect himself against any individual or company, who may have hundreds of thousands to threaten with. Quite recently a small company which was threatened by the Dunlop Company, brought an action against them for undue interference and won their case.

I trust that the above remarks, brief as they are, may assist in clearing away doubts and hesitation on the part of many intending manufacturers. If the present clouds could be lifted, not only would the coming industry show signs of life, but even those who now seek to obtain all the profit, must benefit with the crowd. The Self-Propelled Traffic Association, of which I have the honour to be president, effected good work last year in helping to obtain for the general public an equitable Act for light motor traffic, and now it is equally desirous to secure for every Englishman that which he so highly values—his freedom.

This is a fitting occasion to pay a tribute to the memory of an able engineer and a leader of the motor-traffic movement. Monsieur Levassor expired suddenly last month, leaving a gap which may never be filled again with such intelligence. As a man he was upright and honest; as an engineer he was able and clear headed; as a manufacturer he was conscientious; and as a friend he was true.

I will now conclude by summing up in a few words what I have said in regard to motor-traffic. For motor-cycles, benzine motors probably have the advantage. In all other cases, steam promises to be the motive power when real work is called for, and where a return upon capital expenditure is required. Electric energy, if the necessary adjuncts exist, has a great field open in towns, as a luxury, where the question of upkeep is not a vital item.

Finally, the best existing motor the world has yet seen, for its power, method of fueling, suspension springs, and travelling long distances before re-charging, is one which is likely to remain with us for many a long year to come, whatever may be the future development of motor-traffic. It is known and loved by all, young and old, under the name of the horse.

DISCUSSION.

Mr. J. I. Thornycroft, F.R.S., said they were much indebted to Sir David Salomons, not only for this paper, but for the efforts he had made to lessen the difficulties of those who were anxious to engage in this industry, and especially for the formation of the society which had done so much to lighten those difficulties. With regard to the most suitable power for driving motors, he said that where the work was light electricity had many advantages, but that steam was more suitable where much work had to be done, and in that he entirely agreed with him. They would all admit that steam still held its own, and electricity was only a means of making use of energy, principally of the steam-engine, and conveying it to where it had to be used. In this country we were not fortunate enough to have Niagaras available, but wherever power could be got from Nature direct, there steam would be at a disadvantage. His experiments, however, led him to the conclusion that there was still a great future for steam, especially in towns, and where there were good roads. When it came to loose country roads and inclines as steep as 1 in 5, constructive engineers had their work cut out. With good roads, however, the task was an easy one, and he hoped before long that considerable advances would be made now that legislative difficulties were removed; and he believed, in many cases, steam would be found more economi
than horse-power.

Mr. Carl Oppermann thought there was
difficulty connected with the use of pneumatic ty
which had not been mentioned, viz., what cycl
called sideslip. If the road were much arched,
you were riding on the near side, there was alway
tendency for the car to slide away from the crown
the road towards the side, and he feared that wo
always be so, however well they were made. W
regard to the price of electricity for propulsion, t
was put at 3d. a unit, or 4d. allowing for waste;
in Shoreditch the Vestry were willing to sup
it in the middle of the day at 2d. a unit, wh
made a great deal of difference, and there w
many advantages in an electrically-propelled
Steam was a very good servant, and could do a gr
deal more than electricity, but the man in the st
was rather afraid of it, and thought of explosio
and so on, in connection with it, and for that reas
amongst others, he thought that electric cars ha
wide field open to them. There was no smell
smoke, or steam to get rid of, and an electrica
propelled vehicle was under perfect control,
could stop and start at once. There was an elec
car now made which took 20 to 25 amperes, of
E.M.F. of 60 volts, which would go just over ei
miles an hour through ordinary traffic. He thou
the company promoters had done the whole busi
a great deal of injury, leading people to expect
kinds of things, 60 miles an hour, for instance, wh
were quite out of the question, and the pe
making such statements had no knowledge of
subject entitling them to put them forward.
would take some years before motor traffic was est
lished, for it must be remembered that only since
November had Englishmen been able to experim
and it was impossible to gain any real experie
until the cars had been actually tried on the ro
The Patent-laws were, no doubt, open to g
improvement, but he thought the greatest evil
the indiscriminate granting of patents, the offic
he believed, having no option but to grant a pa
without any search at all. In Germany there w
considerable search made, and when a man g
German patent, he knew he had something valua

Mr. Holroyd Smith, having expressed his tha
to Sir David Salomons for his action in connec
with the society of which he was president,
getting the recent Act passed, said there were a
technical points in the paper which he should lik
touch upon. It was suggested that the reason
there was less vibration in a carriage drawn
horses than in one propelled by machinery,
that there was a sort of undulatory action
the part of the horse, which facilitated
passage of the wheels over obstacles and
equalities in the road. He would suggest (and
illustrated his point by a sketch on the blackbo

at if it could be so arranged that the weight borne the axle were thrown forward beyond the perpen- cular through the axle to the ground, when such an stacle was encountered, much the same effect would produced. With regard to the Patent-laws, he ought it was high time for a strenuous effort to be ide by engineers to get some amendment in them. was nothing less than robbery to take fees from y one for a patent which was of no value. He ired the only people who really benefited by the itent-laws at present were the patent agents and wyers. He only hoped Sir David Salomons would ke the same energetic action with regard to this atter as he did with regard to the Locomotives Act. e wished there were time for a full discussion of the ative merits of steam, electricity, and gas for the rpose of motor carriages, but there was not. was difficult to convey the right impression speaking of gas, oil, and benzoline engines, but would suggest that all such should be termed mpulse" engines. He quite agreed that the use electricity for such purposes was a luxury; he had ven some attention to the question of electrical iction, and could not see his way, with any existing ttery, to recommend it as economical, or as able to mpete in that respect with either a steam or an pulse engine. At present the controversy was tween the two latter, but there was not time to ter into a full discussion of their relative merits.

Mr. WORBY BEAUMONT said he felt flattered by e allusion in the paper to his course of lectures, but ist correct the impression which might be conveyed at they dealt only with the history of the subject, d he had since read papers before the Society of ts and two northern engineering societies, the eveland and the Manchester, which dealt rather ore with the modern advances, and with the practical estions involved. The present paper covered so de a field, that it was impossible to discuss it equately, but he was sure Sir David Salomons ould not object to a little friendly criticism on ints wherein he differed from him. In the first ace, with regard to the different modes of propul- on, he thought it was rather out of place to say at either steam, air, gas, oil, or electricity was st; there were cases where each was suitable, ough the application of some was more limited an that of others. The question of expense was t the only one, and the difference between the ork to be done in one place or another would affect e motive power to be adopted. Steam might be st for certain purposes in certain districts, whilst a s motor would be preferable in others; and in ite of all that was said about it, an electric motor ght, if not more economical, be on the whole tter suited to another locality. It was quite true ain, that in many cases too little power had been t into the cars, but he could not agree that the power cessary was such as would take a car, at the rate of miles an hour, up steep hills as well as on a level road. It would be a great waste of fuel and money to be taking motor-cars up hills of a gradient of 1 in 10, at anything like the rate which would give an average speed of 12 miles an hour. If railways had to be worked under anything like such conditions we should never have had railways at all. If we were to use the roads, simply because they were there, and were convenient, we must use vehicles and powers having some relation to the nature of those roads. If they were to use such high powers as had been suggested it really meant that they would want nearly all the power they could get into a motor-car to carry the motor itself. They would never get on until they admitted that the conditions under which horse traffic was conducted must, to some extent, be observed in regard to hill climbing. Vehicles must be used provided with gear which would drive them up hill at a slow rate, so that a smaller mean horse-power might be used. Many interesting points were suggested as to the horse-power of an engine and the horse-power of an animal, but it was difficult to say what a horse-power really was. He had known a horse to exert about 12 horse-power for an appreciable length of time, and any day in London you might see horses exerting for a short time at least 8 horse-power. But that same one horse-power was quite incapable of doing what a mechanical one horse-power engine would do as soon as it arrived at anything like the normal speed at which it was designed to run. It was because of his great range of power—great power at low speed and small power at high speed—that the horse was such a useful animal, and would always remain one of the most useful tractors we could have. With regard to the question of elastic tyres he could not quite agree with Sir David Salomons, because a lot of the work which was done in the use of heavy wheels with iron tyres was quite thrown away; the work done in lifting the wheel and dropping it again against the resistance of and under the recoil of springs above the axle, and the crushing of stones, was disadvantageous as compared with the compression of a pneumatic tyre, which had a perfectly elastic material to form the spring, namely, air, whereas indiarubber was imperfectly inelastic. Of course there were other reasons for using a solid rubber tyre, because it would carry a load, which one could not at present carry so well on the other. The questions raised with regard to the Patent-law he would prefer to leave for the Chairman to deal with, but some of his suggestions were undoubtedly original. He could hardly follow those who thought it was a dreadful thing that a man who worked out a provisional specification found he had been anticipated. That was one of the risks which an inventor must run, and it was a risk which he ran at a very cheap rate under the present law, and if this were altered they would have to go back to the old days of enormous fees. The only suggestion he was inclined to make was that provisional specifications should be abolished.

Mr. A. R. Sennett said it was impossible to discuss the whole of this interesting paper in one evening, and he must content himself with mentioning one or two points in which he differed with Sir David Salomons. He was much surprised to hear him say that he thought the tyre of the future would be a steel tyre. He had previously pointed out that a carriage going over an ordinary road, came on stones, &c., and so performed a sinuous path in the vertical plane and, of course you wanted to reduce that sinuous line as nearly as possible to a straight one. That was where the reduction of friction by the use of the pneumatic tyre came in. If you removed vibration in the body of a carriage by improved springs, you could not at the same time hope to reduce the tractive force required; and there was another important constructional consideration, and that was that one of the great troubles which engineers and carriage builders had to contend with, was the destructive effect of vibration on road carriages. If you wanted to strike at the root of the evil, you must take measures at the very edge of the wheel. The next best thing, as was pointed out in the paper, was an efficient pneumatic axle, but there was no doubt that the use of a pneumatic tyre, apart from the reduction in tractive force, would have the effect of materially increasing the maintenance expenses of road carriages, and by the time the other difficulties had been overcome, they would probably have an efficient pneumatic tyre. He also differed from Sir David Salomons with regard to what he might call his fad, that a motor-car should run at a constant speed uphill and down. That entailed putting an unnecessary weight of mechanism into the carriage. He thought it would be more reasonable to design the car to run uphill at half the speed of the maximum on the level. Six miles an hour was a good speed for moderate hills. You could always run a steam-engine for a reasonable time at at least twice its normal speed, which was decided upon from considerations of upkeep, &c. He should, therefore, suggest the use of a varying gear, and in travelling up hills, doubling the speed of the engine and halving the ratio of the gear, so that you would multiply the power by four; so that a carriage of 5 horse-power became, for the time being, one of 20 horse-power. Where you were using an accumulator, which you virtually had in the Serpollet system, you could get even a higher speed. It was wonderful how the Serpollet carriage negotiated hills, by the aid of the thermal energy stored up in the tubes, but he doubted whether it would work so well with hills five miles long, such as had been described. With a variable gear, however, such as he had referred to, it would not matter what the length of the hill was. Perfect as the Serpollet carriage was with its coke fire, he quite anticipated that it would be much better with the petroleum burner, because the burner in itself was a most efficient accumulator, as you could increase or decrease the power of the flame at will. It had been
pointed out that the horse was a very perfect trac
having this great advantage over the steam-engi
that it could exert its maximum power in starting
carriage, and the author said there had not b
much improvement in the design of the ste
engine. The weak point in the locomotive of to-
was in its power of starting; but that was beca
no one would dream of putting a variable gear o
locomotive which travelled at such a high speed.
you put a varying gear into a road-carriage you
the same conditions as in the case of the horse;
you might have the gear varying infinitely, so tha
moved off at a fraction of a mile per hour, while
engine was running at full speed. If you had
stop the engine you had less power, and were r
ning it under the same conditions as a gas-engi
but by using a variable gear you could start with
maximum power. The question of electrical tract
on canals was well worth attention he belie
it had been tried on a considerable scale in Fra
He could not help thinking that in certain distri
and for certain purposes, such as that of the butc
and baker, electric traction might have an advant
over horse-power. He would not discuss the qu
tion of Patent-law, but he hoped some compet
person would bring it up in a separate paper.

Mr. A. H. Stanley, as a patent agent, poin
out that even if the fee were returned, it wo
only be £1, whereas the total fees were fr
3 to 5 guineas. All conscientious patent age
advised their clients in about 50 per cent.
cases brought to them not to proceed with
patent. He also pointed out that the ow
of a patent must be registered, or he could t
no action for infringement, and the registe
owner could always be ascertained. The Ameri
system was very expensive, and entailed a loss
about £70,000 a year on the Government.
German system also was much more expensive t
the English as there were heavy annual fees,
very stringent regulations with regard to working.

The Chairman said the discussion had been v
interesting, and to him rather amusing where
treated on the question of the Patent-laws, ab
which he knew something from practical experien
If he had any doubt about his income from pat
business being in danger, he should certai
encourage Sir David Salomons to go about
country and persuade manufacturers that if t
wanted to free themselves from the tyranny of pate
they should perpetrate an infringement and see w
came of it. When he was at Cambridge he reme
bered Charles Kingsley's preaching in St. Mar
Church, and an agonised shudder running throu
the crowded congregation when he said in the m
earnest manner, "If any of you young men th
that doing wrong will not bring its punishment in
world, just you try and see;" and he could not h
thinking of that when it was suggested that i

son infringed a patent £100 would see him through he certainly should not like to add his guarantee to t of Sir David Salomons. He earnestly sympathised h the desire to make the patent laws as perfect as sible, but that was mainly because of his sympathy h inventors. He had known a man work for years a thing and at last bring it to perfection, and bably a great part of the development had n in the direction of simplicity; and if when an had not only succeeded in doing a thing, in doing it very cheaply, he was to be told t his reward must be only one-tenth of the t, it would be a very small stimulant for the best entive work. To refer to the telephone, one of greatest inventions of our time, a Bell's receiver ld be made for 6s., and as good a transmitter as one could wish for about 6d., and if it was sug- ted that the officials in the Patent-office, or any- ere else, should decide what was an adequate re- neration for such a gift to the community, he ught the system would only have to be tried for a y short time before everyone with any sense of tice would cry out against it. He felt the difficulty regulating these monopolies, so that they should hamper trade, while at the same time bringing a fair urn to inventors, but the more he saw of it, the re he felt convinced that the commercial com- nity must decide what was a fair return to the entor by the extent to which it availed itself his invention. For years there had been a wer given to go to the Board of Trade and get a npulsory licence, but he did not believe there was single instance in which that right had been rcised. He should like to have a good paper d there on the Patent-laws, for there were un- btedly many defects, some in the direction inted out, in which manufacturers were harassed rubbishy patents; but there were also others in opposite direction, where a person in possession a patent saw it infringed on all hands, and could t stop it: and these defects everyone interested her in manufactures or in invention must desire to removed. But he feared it required a little more rching investigation into the condition of the law in the reader of the paper had made before it could improved. For example, he suggested that a tent should be void if the owner was not registered; t if he had looked a little into the law, he would ve found that the man who was registered was the ner, and no one else had any right of action. ere was not a patent in existence of which the ner could not be found by searching the register. ith regard to the difference between the American d German law and our own, those systems were ry bad for poor people, because they involved long vestigations which were usually very expensive. England it was well known that the bulk of tents were dropped, being found to be of no value, d the only fee paid was the first. In England it s thought better to grant the patent, and then ve the person to drop it afterwards, and generally, unless it was of some value, that was what happened. The suggestion that the fee should be returned, must come home to everyone; but the idea of getting any fee returned from the Government, was one they were hardly accustomed to, and he feared that even Sir David Salomons' energy would fail to get it carried into effect.

Sir DAVID SALOMONS, in reply, said with regard to the employment of different motors in various places, he quite agreed with Mr. Beaumont, and he should be the first to recommend electro motors, either where water power was available, or where ratepayers were behind the electric installation, and it could be obtained for 2d. per unit. It often happened in such cases that no provision was made for a sinking fund, but only for paying off the loan as they were bound to do by Act of Parliament, and there the ratepayers had to bear the brunt, whilst companies and others dealing in electricity had to proceed in a commercial manner. In the City of London power would not be supplied under 3½d. or 4d. A great deal had been said about speed up-hill, but he thought it was evident that Mr. Sennett and others had not ridden much in a Serpollet carriage. He mentioned that, not with any preference for the Serpollet system over any other, only M. Serpollet was the only man who had brought steam on roads to anything like perfection. Instead of putting a large amount of weight into the engine and boiler in order to get up hill at a decent speed, the difference was hardly worth talking of, much less than the weight of a gear, which everyone desired to get rid of. He would give £100,000 or £200,000 for any patent which would get rid of gear and get direct driving in all cases. Mr. Sennett was evidently wedded to oil-motors, in which gearing was a necessity. He had always contended that the great virtue of steam, and most of those who had had to do with it would bear him out, was that you got rid of all that unnecessary machinery and complication which was involved in the gear and clutches. When you travelled with an oil motor and dropped down suddenly from 18 miles an hour on the level to three, four, or five miles an hour on a hill, you were thoroughly dissatisfied; but those who had gone in a steam carriage from Paris to Versailles, traversing a hill of nearly five miles, about 10 per cent. gradient, at 12 miles an hour, were quite satisfied it could be done with ease. With regard to patent law, it was quite true that no action could be taken by anyone not the registered owner, but sometimes the registered owner was only a man of straw, and kept there for the time being. The telephone case had been mentioned as one in which the profits ought to be large, and if the inventor had got the profits he should not have begrudged them, but they all knew that in these cases the money generally went into the wrong pockets. He simply mentioned 10 per cent. as what seemed a fair figure; you might say

20 per cent.—that was a detail; but he would point out that if in the telephone case 5 per cent. had been fixed, the owners of the patent would have made a hundred or a thousand times as much as they did, as there would have been millions of the instruments made. This was shown by the enormous development which took place when the patent expired. The reason people did not get compulsory licences from the Board of Trade was very much due to the fact that the expense might be enormous, and further, he was not sure whether if such a license were obtained it would not have to run for the whole term of the patent the same as one taken by agreement, even though the patent were upset.

The CHAIRMAN said it would only last during the life of the patent.

Sir DAVID SALOMONS said that was an important point, and he was glad it had come up and been answered on such good authority. Time did not permit to deal with the other points raised during the discussion.

The CHAIRMAN then proposed a vote of thanks to Sir David Salomons, which was carried unanimously, and the meeting adjourned.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

MAY 19.—"London Water Supply." By PERCY F. FRANKLAND, Ph.D., F.R.S. SIR DOUGLAS GALTON, K.C.B., F.R.S., will preside.

INDIAN SECTION.

MAY 20, AT 4.30.—"Kerman and Persian Beluchistan, with special reference to the Journeys of Alexander the Great and Marco Polo." By CAPT. P. MOLESWORTH SYKES. SIR H. MORTIMER DURAND, K.C.S.I., K.C.I.E. (Envoy and Minister Plenipotantiary in Persia), will preside.

CANTOR LECTURES.

Monday May 17, at Eight p.m.:—

LEWIS FOREMAN DAY, "Design in Lettering." Lecture III.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. L. F. Day, "Design in Lettering." (Lecture III.)

Geographical, University of London, Burlington-gardens, W., 2½ p.m. Annual Meeting.

British Architects, 9, Conduit-street, W., 8 p.m.

Medical, 11, Chandos-street, W., 8 p.m. Annual Oration.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Paper by Dr. G. U. Pope.

TUESDAY, MAY 18...Royal Institution, Albemarle-street, W., 3 p.m. Dr. Tempest Anderson, "Volcanoes." (Lecture IV.)

United Service Inst., Whitehall-yard, S.W., 3 p.m. Colonel E. C. Brown, "The Instruction of c Soldiers to Shoot under Active Conditions Service."

Pathological, 20, Hanover-square, W., 8½ p. Annual meeting.

Photographic, 12, Hanover-square, W., 8 p.m. M T. Huson, "Notes on the Working of the Phot Aquatint Process, and on some of the Apparat used."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. M G. A. Boulenger, "A Revision of the Lizards the Genus *Sceloporus*." 2. Dr. G. Herbe Fowler, "Contributions to our Knowledge of t Plankton of the Faeroe Channel" (Part II.). Mr. Martin Jacoby, "Further Contributions to t Knowledge of the Phytophagous Coleoptera Africa, including Madagascar" (Part II.).

WEDNESDAY, MAY 19...SOCIETY OF ARTS, John-stree Adelphi, W.C., 8 p.m. Dr. Percy F. Franklan "London Water Supply."

Royal, Burlington-house, W., 9 p.m. Soirée.

Meteorological (in the rooms of the Astronomic Society), Burlington-house, W., 4½ p.m. 1. M C. V. Bellamy, "The Rainfall of Dominica, Wes Indies." 2. Messrs. R. H. Scott and F. Gaste "The Mean Monthly Temperatures of the Britis Isles, 1871-95."

Microscopical, 20, Hanover-square, W., 7½ p.m Exhibition of Specimens of Injections and othe Objects, by Mr. Ernest Hinton.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m Annual Meeting.

Archæological, 32, Sackville-street, W., 8 p.m.

Mining and Metallurgy, Geological Museum Jermyn-street, S.W., 8 p.m. 1. Mr. A. G Charleton, "Mining Accounts and Cost Sheets." 2. Mr. J. Douglas Hay, "Notes on an Electric Drill." 3. Mr. G. A. Denny, "Notes in a Examination of a Mine in the Klerksdorp District."

THURSDAY, MAY 20...SOCIETY OF ARTS, John-street Adelphi, W.C., 4½ p.m. (Indian Section. Captain P. Molesworth Sykes, "Kerman and Persian Beluchistan."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m.

Chemical, Burlington-house, W., 8 p.m. 1. Mr. Holland Crompton, "The Theory of Osmotic Pressure and the Hypothesis of Electrolytic Dissociation." 2. "Molecular Rotation of Optically Active Salts." 3. "Heats of Neutralisation of Acids and Bases in Dilute Agneous Solution." 4. Mr. John Spiller, "The Platinum-Silver Alloys; their Solubility in Nitric Acid." 5. Mr. A. E. Tutton, "A Comparative Crystallographical Study of the Normal Selenates of Potassium, Rubidium, and Caesium."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. Churton Collins, "The French Revolution and English Literature." (Lecture I.)

Historical, 28, Jermyn-street, S.W., 5 p.m.

United Service Institution, Whitehall, S.W., 3 p.m. Lt.-Col. T. Tulley, "The Battle of Shiloh (or Pittsburg Landing), 6th and 7th April, 1862."

FRIDAY, MAY 21...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Lord Kelvin, "Contact Electricity of Metals."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, MAY 22...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. J. A. Fuller Maitland, "Music in England during the Reign of Queen Victoria." (Lecture I.)

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FRIDAY, MAY 21, 1897.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening, 17th inst., Mr. Lewis . Day delivered the third lecture of his ourse on "Design in Lettering."

The lectures will be published in the *ournal* during the summer recess.

CONVERSAZIONE.

The Society's *Conversazione* will be held at he South Kensington Museum (by permission f the Lords of the Committee of Council on ducation), on Wednesday, 16th June.

Each member will receive a card for himself, hich will not be transferable, and a card for a dy. In addition to this, each Member will e able to purchase additional tickets, the rice of which will be 5s. each up to the day of he *Conversazione*; on that day the price will e raised to 7s. 6d. It is requested that Memers requiring these additional tickets will ake early application for them. Every appliation must be accompanied by a remittance.

Further particulars as to the musical and ther arrangements will be published in the *ournal* later on.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The fourth meeting of the Congrès Interational de l'Enseignement Technique will be eld this year in London, commencing on the 5th of June next. The previous meetings of e Congress were—in 1886 at Bordeaux, in 889 at Paris, and in 1895 at Bordeaux. The eetings will be held at the invitation of the ociety of Arts, and of the Worshipful Companies of Mercers, Drapers, Fishmongers, oldsmiths, Merchant Taylors, Vintners, lothworkers, Leathersellers, and Carpenters.

The Congress will be opened at 11 o'clock, on the 15th of June, by an address from the President, the Duke of Devonshire, K.G., and from the President of the last Congress, M. le Professeur Léo Saignat. The meetings will be held on Tuesday, Wednesday, Thursday, and Friday, from 11 to 1, and from 3 to 5.

Mons. Felix Martel, Inspector-General of Public Instruction, has been appointed delegate by the French Government, and Mons. Eugène Rombaut, Inspector-General of Industrial and Professional Education, by the Belgian Government.

The subscription to the Congress, for others than delegates of foreign Governments, members of the Society of Arts, or liverymen of the companies subscribing, will be five shillings. This will entitle them to a copy of the report of the proceedings.

Applications for persons desiring to become members of the Congress can now be received, and should be accompanied by the amount of the subscription. In return for this a ticket will be sent entitling the members to all the privileges of the Congress.

Members of the Society of Arts and liverymen of the companies will be admitted to the meetings of the Congress on signing their names at the door.

The subjects for discussion at the Congress will include :—

Industrial Education :—

1. Advanced Instruction. Polytechnics, Universities, Colleges.
2. Secondary Instruction. Higher Technical Schools ; Secondary and Intermediate Schools ; Evening Schools.

Commercial Education :—

1. Advanced Instruction. Colleges ; High Schools and Institute of Commerce.
2. Secondary Instruction. Commercial Schools ; High Schools ; Classes for Adults.

It is not proposed to deal with elementary Industrial or Commercial Education. The education of both sexes will be included.

The meetings will be held in the Rooms of the Society of Arts. Should it be found desirable to arrange for sectional meetings accommodation will be provided in the neighbourhood.

The papers will be printed and distributed at the meetings. The reader of each paper will be allowed twenty minutes to state the substance of the paper. Other speakers will be restricted to ten minutes.

The proceedings of the Congress will be reported in English. Papers intended for the Congress may be in French, German, or English, and speakers may make use of any of these languages.

All communications relating to the business of the Congress should be addressed to the Secretary, Society of Arts, John-street, Adelphi, London, W.C.

The Right Hon. the Lord Mayor of London has kindly expressed his intention of inviting members of the Congress to an evening reception at the Mansion-house, on the 17th of June. The Society of Arts annual *Conversazione* will be held on Wednesday, the 16th of June, and members of the Congress will receive an invitation to it. On Saturday, the 19th of June, it is proposed to organise an excursion, for foreign delegates.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, May 11, 1897; FRANCIS COBB in the chair.

The paper read was—

A HALF-CENTURY OF LINE ENGRAVING, 1780-1830.

By GEORGE CLULOW.

I wish first to warn you that the breadth of the subject of my paper as indicated by its title will be found considerably narrowed in its delivery by reason of the limitation of time, and more so by the limitation which I have placed on myself; my object being briefly to call attention more particularly to one application of the art of engraving in England, which had its rise and decline within a period of half a century, a period, however, which produced in great quantity work which I believe to be worthy of careful study and of being carefully preserved.

Many of you probably are familiar, but I trust not with that familiarity which breeds contempt, with the little duodecimos, generally in shabby browns and often denuded of all the charm of gold tooling and lettering which once gave exterior beauty to the dainty little books which enshrined the poets, essayists, and novelists of the later years of the last century, and with the like-sized books in the brighter clothing of reds and greens and purples covering the collections o prose and poetry which, under the various names of Bijou, Souvenir, Amulet or Annual which gave the motive for the production o some of the most charming of the engraved work of the fifty years between 1780 and 1830.

It is of the illustration of these little books I am about to speak; before, however, I do so you will pardon me if I assume that possibly there may be present a few to whom the art o engraving, as it must be understood in this application of its several methods, may not be entirely familiar, and I will very shortly indicate the methods which at the momen most interests us.

Some of you have probably seen in the Museum of Antiquities in the Louvre that wonderful specimen of engraving, upon which is recorded in Phœnician characters the account of some of the conquests of a king o Moab 3,000 years ago, and all of us are familiar with the small pieces of copper on which fashion prescribes that our names shall be inscribed by the engraver to be used in the production of the visiting card of to-day.

Now it is a very wide step between the Moabite stone and a visiting card, but there is yet a broad identity between them as to the method by which their markings are produced, for both are incised, the rough chisel on the basaltic stone of Moab finding its exact counterpart in the more delicate graver of the card-plate. Both then are incised, that is—the level surface is cut by incision—and both are in intaglio. I will return to the familiar card-plate, and let it serve me in illustration. You see in such a plate that the character, in imitation of writing or of some variety of type, has been sunk below the surface. If a suitably prepared stiff ink is rubbed over the surface in such a way that the sunken hollows of the plate become charged with it, and then that surface is cleaned or cleared of the ink upon it, the hollows alone remain filled with the ink, the plate thus charged being placed under the rollers of the copper-plate press with the sheet of paper or card which it is desired to print in immediate contact with it; the ink in the hollows of the plate is given off to the paper, and we have then what is technically called a print. The process is precisely the same whether the plate be a common card-plate, or an etching by Rembrandt.

I have spoken so far of the incised work as produced by the graver, which is, in effect, a finely-pointed chisel; there is, however, another method by which the incised work is produced on the plate, namely, by the erosion of the metal surface, be it copper or steel, by aquafortis. In this case the plate is coated with a thin film of varnish, upon that film the engraver draws the design with a fine needle, the needle cutting through the film and laying bare the metal beneath; the plate is then subjected to the action of aquafortis, which in all the exposed lines bites into the metal, and in this way plays the part which, in the other case, is taken by the graver. This is crudely put, but I hope it is sufficient to convey to you a general idea of the operations.

On the screen you will now see an example of the result of each of these methods. The first is "The Young Novice," engraved by Greatbatch, after a picture by Northcote, and the work is entirely that of the graver; and the second is after Turner's "Greenwich Hospital," engraved by William Finden; with the exception of a few lines on the boat and the figure in the foreground, this is all etched, that is, the lines are formed by the action of aquafortis alone. This is, of course, an impression from the first state, as it is called, of the plate, pulled for the purpose of the engraver, and in its completed state, as you now see it, is worked upon by the graver. I shall have occasion to refer to both of these again.

It seems to me that of all the arts which have sprung from that of design, there is none except architecture and painting which has given pleasure to so many, or has been of so much benefit in shaping correct ideas as to form, and of educating the eye and the intelect as that of engraving, whether on metal or on wood, though with the latter we have nothing to do to-night. By means of the burin of the engraver we have had brought within the mmediate reach of nearly everyone the best work of the artists of all countries and periods, and it has served in many cases to preserve to us priceless designs which would have been otherwise lost. Very much of the work of the great artists of three centuries ago exists only now by the copies made contemporaneously by he engraver. Engraving, moreover, has proved o literature and the right understanding of it, an aid which entitles it to take rank with literature itself. John Evelyn most happily speaks of a picture, and he had in his mind an engraved picture, as a kind of universal language, for he says that "although it has no ongue it can yet speak and convey instruction;" how true this is we know by our every day experience.

Although I claim for England the possession of a distinct school of engravers, worthy in their way to be called "little masters" as much as the "little masters" of Germany of an earlier period, I admit that we cannot be said to have had a school of engraving before the middle of the last century. We had however a hundred years earlier a few able and distinguished men who as engravers have left a broad mark for themselves; I need only mention Elstracke, Delaram, Faithorne, and Hollar, and later the names of Hogarth, Woollett, Strange, and Sharpe occur naturally to us. Of the brilliant cluster of engravers in mezzotint of the last century we have no concern at the moment, tempting as it is to speak of them; what the fame of Sir Joshua Reynolds for example owes, to such engravers as McArdell, Houston, Fisher, Grozer, Valentine Green, Pether, and others is known to us all.

But I am being tempted into the broad fields and out of the path upon which I have set out, for it is with the illustration of books by the "little masters" of whom I have spoken, that I have to deal. Prior to the last quarter of the 18th century, the illustration of books had been confined for the most part to the delineation, with more or less accuracy—generally considerably less, I apprehend—of the features of historical personages, or the subjects of biography, and archaic representations of historical events, but there had been little attempt to create the actual circumstance and incident of the novelist, poet or historian, in a realistic way. The books which are in my mind as marking a distinct epoch in the art of illustration by engraved plates, appeared in 1780 as "The Novelists' Magazine," which seemed to suddenly focus within its pages a new school of artists and engravers in line, the name which stands out the most prominently among the artists of that period being that of Stothard, and those of James Heath, Sharp, Goodall, and Finden among the engravers. A fashion was set, and a pretty fashion it was, and able and accomplished craftsmen were found to give it ample expression; such men as the Heaths, the Findens, Neagle, Noble, Fittler, Freeman, Ridley, and Bartolozzi, gave us things of beauty in constant succession. I do not attempt to give a catalogue of names of all the clever engravers who were occupied upon the book illustration of that period, but I know that I am finding for you a wide source of enjoyment in indicating so much as will induce you to seek further for yourselves. I have selected Stothard as an artist to serve as a kind of text, because he was perhaps the designer most in demand by the publisher, and whose work passed into the hands of tha largest number of engravers for reproduction. I want to be, nevertheless, understood as not selecting Stothard because his work was uniformly better than his *confrères*, because there were others, and notably Westall, who, less prolific, attained a high average of artistic excellence, but there is an almost constant charm about all that Stothard did, and we linger admiringly over the exquisite grace and proportion of most of his compositions; the tenderness of his invention, the charm of his line and the propriety of his accessories. Nothing in English art excels his children and young girls, and he is alike a master in depicting an English cottager child, and the *belle dame* of society. Let us stay for a moment and look at the examples which I have selected in illustration of this.

As was Sir Joshua Reynolds with the mezzotint engravers, so was Stothard fortunate in finding men to engrave his designs who were in fine artistic touch and feeling with him, men, indeed, who would seem to have found their gravers inspired by the grace and beauty of his design. It is almost invidious to discriminate among such names as Allen, Fox, Humphreys, Goodall, Goodyear, the Heaths, and the brothers Finden, all of them so excellent. On the screen you will see examples of their work, among others, and I may safely leave you to form a competent opinion of their relative merits. I want you, however, to bear in mind that the examples I have selected for you appeal to me as representative of the highest attainment of this art of engraving "in little," which is to me so impressive and interesting, but do not forget that outside of them are hundreds of examples full of beauty and as good in interest artistically and technically.

I would also have you keep in mind that as you see these engravings on the screen they are enlarged to from 40 to 60 times the height of the originals, and that some of them only an inch high are seen on the screen enlarged to six feet, because it is on this point of scale that I desire you to share with me the admiration of the consummate draughtsmanship of the engravers, who, without contemplating the severe ordeal which their works thus undergoes, prove the claim good, which I make for them, as being very much more than mechanical reproductions of the original work of the designer. The artist worked, of cours
to the scale of the intended reproduction—
was long before the days of photography, an
its resultant and often abominable processes-
and one is frequently impressed by the fa
that the engraver has seen, and has had th
ability to correct, the small shortcomings of th
artist. I do not intend by this to disparage th
very beautiful work in miniature, for such it i
which was created by such men as Stothar
Lawrence, Burney, Westall, and others ;
would be rank heresy, perhaps, to suggest th
Turner could have been improved by his e
graver, but I will venture to say that even
had no reason to complain of the interpretatio
which his compositions received at the hands
the artist-engraver. I wish that it had bee
possible to have placed side by side th
original and its engraving, but I can only no
put before you the examples which are selecte
in illustration of what I have said.

The screen has now on it one of the illustr
tions to Rogers's "Poems," by Stothar
engraved by William Finden. It is an ear
working proof, and it shows the early stag
of the etched, and also of the engraved lin
and well indicates how the landscape portio
are laid in with the etching needle, and th
figures by the graver. It is followed by
finished proof of the same subject, and show
how the lines are deepened, crossed, and inte
lined to produce varying degrees of the shado
and of tone, variations in intensity, which gi
what is well described as "colour." In th
next we see the use of stipple. Here let m
remark that I do not exclude the dot or stipp
as an adjunct to the line, for with it we ha
an aid to modelling and colour.

"Children on the Seashore," engraved
J. H. Robinson, after Stothard, which I ta
as an example of extreme freedom in laying
the line and figures—nothing laboured, b
every line telling and giving its proper val
in colour and tone—it is beautiful in its e
pression : note the expectant eagerness of th
child in arms and the kneeling child.

An example of Charles Heath, aft
Corbould, excellent in the simple treatme
of the engraved line, as seen in the wavele
in the immediate foreground.

Bust of Homer, from the Du Rover
Edition of Pope's "Homer" published
1805. Designed by Burney and engraved
Schiavonetti, the bust and figures in th
frieze are all done with the graver, the re
is etched.

Here is a charming illustration after

Thomas Lawrence, by Thompson, lovely in pose and modelling, and suggesting the inspiration of the engraver by the exquisite drawing of the original.

"The Embarkation," a subject treated after the manner of Turner, by Whichelo, and engraved by Robert Brandard, who was painter as well as engraver. This is one of his earliest plates. The slide is from a not very good impression but it serves to show how well the abundance of small detail bears enlargement. In this plate the lines have been laid in by etching, as in the Greenwich plate after Turner and afterwards re-entered with the graver and the shadows and the darker tones re-bitten.

"Cleopatra Embarking," after Danby by Goodall. I have selected this as similar in subject to the last, and as showing a different handling but similar mastery of small detail; the method is much the same, but it s not seen at its best owing to the impression not being a good one.

The Medici Vase and a Bacchanalian Vase, both are from Rogers's "Poems," designed by Stothard and engraved by Allen. You will observe the even quality of line on both, a compound of etching, crossed and intersected with fine graver cuts; the careful exactness of work should be noted, he height of the figures in the Bacchanalian Vase being only a quarter of an inch.

Here again is Stothard in one of the ilustrations to Walton's "Angler," engraved by inden. It is a good specimen of mixed tched and graved work, the landscape, grass, nd foliage being all bitten, and the figures ll graved—the grass in the foreground is interned with fine graver cuts to give harmony and uiet tone; the size of the original is under two ches, and the tallest figure less than an inch. ote the head of the elder woman, which is ll of expression, though in the original only eighth of an inch in size.

"Pilgrim and Group of Young Girls" now the screen is another of the Stothard illurations to Rogers's "Poems," and is a fine ample of William Finden's smaller work. e whole of the figures are in pure line, the ass is etched, the shadows in the grass being epened with the graver; in the original the ure of the pilgrim is a little more than an inch gh, the faces are less than an eighth of an inch.

"The Travelling Musicians" is another of illiam Finden's plates; the whole of the ures being graver work, the features have tremely fine dots to give small shadows. Can anything be more exquisite in expression than the face of the musician, and the upturned face to the left.

"Cora"—a group of Amoretti surrounding the figure of the young girl—is another of William Finden's plates after Stothard; the whole height of this is but 1¾ inches.

Here is another of the smaller plates after Stothard but engraved by Goodall, "The Waterfall," in mixed etching and graved line. Notice the extreme delicacy of the background; as a piece of miniature engraving it would be difficult to surpass. We have here another engraver after Stothard—Shenton—less prolific than most of his contemporaries, but with wonderful vigour and force in his line. In this example—which, without being quite sure of it, I will call an illustration to the "Babes in the Wood"—the horses and figures are fine graver work, intelligent and with a keen perception of colour; the landscape and sky are etched—probably a little overdone if brilliancy is sought—but the whole composition is harmonious and very pleasing.

On the next two slides we have two other engravers after Stothard, both displaying the same delicacy in handling of small subjects and minute figure work.

The "Death of Raphael," by J. H. Robinson, who was Associate engraver of the Royal Academy. Notice the beautiful liquid flow of the graver lines on the figures throughout; all the figures are very small, the whole composition being less than 2½ inches high.

"Taking the Veil," by Humphreys. Here the figures are all graved, the rest etched; the line in some parts of the draperies is a little harsh and metallic, but as a whole it is a fine print.

"The Young Novice," engraved by Greatbatch, after Northcote, now on the screen and which we have seen before, is all graved; the open book with the fine lines of writing is but three-quarters of an inch high, and is a *tour de force* of manipulative skill with the graver. The value of gradated line is very effectively seen all through this plate.

"The Fairy of the Lake," after Richter, by Edward Finden. In this plate great brilliancy is given to the figure by the extreme closeness of line in the landscape; the graver work, especially in the hair, is very fine.

"The Vintage," after Stothard, engraved by Goodyear. In this plate brilliancy is obtained by closeness of background in contrast with the high lights in the figures; there is remarkable quality in the engraving of the head of central figure.

"Capture of the Wild Boar." We have here a similar effect gained by fine stippling over the figures, drapery and cloud; the effect is delicate and has great charm, but does not compare well with the results obtained by direct line.

"Girl with Basket." We have here another example of brilliant effect gained by contrast —though in this instance at the expense of some truth—the etched background being throughout too massive and dark.

This example engraved by Chevalier—the figures being all graver and the landscape etched—avoids the fault of the preceding plate, while it is not less brilliant and is altogether more harmonious.

Here is a plate engraved by mixed methods —etching, graved line, and stipple—portions of the figures and background being by the latter method; it is shown as an illustration of styles but is the least good of the series.

"Mary Queen of Scots," by Fox, nearly all graver—the darker parts bitten and afterwards gone over with the graver.

This is a plate by Davenport which is shown as worthy of a place with the work of the better-known engravers with which it is in company. It is combined etching and graving, and has a pleasing and harmonious effect.

I now return to examples from Stothard—the temptation has been not to leave him—and here we have his conception of "The Poet" engraved by Charles Heath. The figure and drapery are all done by the graver, while the background and accessories are etched, crossed with fine graver lines; for so small a subject there is wonderful strength all through, and on the screen it has the effect of an engraving originally of large size.

"The Dance"—engraved by Fox. This is the smallest in size of the examples which you have seen to-night, and despite some trifling exaggeration of details, it is the one which marks, to my mind very emphatically, the claim of these "engravers in little" to a cleverly trained and skilled draughtsmanship. The original is exactly an inch high; the figures are all by the graver, the rest etched.

Next we have two subjects engraved by William Finden. Note the great simplicity and freedom in arrangement of lines, and in this single figure the accurate drawing and sense of motion which it conveys.

We have now four landscape studies, all engraved by Finden, after Turner. To me they seem marvellous in their subtle expression of colour and of size, although the originals are none of them more than tw inches high.

A pretty composition—a domestic group again by Stothard, and engraved by Willian Finden. The graver and etched work ar together here in most happy and effectiv conjunction.

With the four friezes after Stothard, als engraved by William Finden, the illustrations end. Of their claims as compositions, I need not, I feel, speak; of thei beauty and grace you are able to decide and as examples of the masterly union of th etching needle and the graver, it is not, I conceive, possible to find finer examples amon the group of artist engravers which I have s imperfectly reviewed, or, indeed, among th engravers of any time or country. I hop that I may, however, have, to some at least directed attention to a branch of the beautifu art of engraving which has not been fully explored, and which has in it a source of grea artistic gratification.

What the outlook for the engraver is now-adays I can not say. It would seem as if i was a case, not of there being no longe men able to produce such work, but rathe that they have been starved out of existence We can only look regretfully at the fact tha an art so charming has all but died out wit us, and hope that some turn of the tide o demand may again bring it into vigorous life

DISCUSSION.

Mr. **Hunter Donaldson** said he was not abl to give an opinion of any value on the technica questions which had been alluded to, but he had great love for the art, an intense admiration for th means by which these delightful works were produce and an abiding interest in the art of the period t which the paper specially referred. It was ver desirable that they should all be better informe with regard to the technical skill involved in suc work, and he much regretted that the wretche things called "process" blocks were in danger o extinguishing the art. Whatever interest or meri there might be in the "processes," one must fee that the earnest effort, care, and consummate skill which had gone to the production of such beautifu works as had been shown on the screen, were mostl wanting in process work. Many of the thing published in the illustrated papers were literall criminal in their worthless character; they degraded art, and he feared the rising generation woul have but a very imperfect idea of what art really was He hoped the time would come when the publi would appreciate such things as had been shown, and when they would feel that only by conscientious devotion could any works of art be produced which were likely to live.

Mr. PHILIP NORMAN said he had made no special study of line engraving, but everyone must admire the great technical skill of these men who interpreted so delightfully the work of others. They must have had astounding eyesight, for it was marvellous how they could have drawn with such precision in line on such an exceedingly small scale. It seemed as if a certain fashion of painting produced a certain style of illustration which suited it. For instance, how admirably Stothard, who was such a graceful and charming artist, was interpreted by these line engravings; they seemed exactly to suit the airy grace of his style. Again, how beautifully mezzotint reproduced those splendid portraits of the latter part of last century. He feared science had been too much for this delightful art, and that the prospect of its revival was not very hopeful. However, one form of intaglio engraving, namely etching, was now much in vogue, and some productions of the modern painter-etchers were very beautiful works of art.

Mr. HUGH STANNUS agreed fully with what had been said by Mr. Donaldson. He would also wish to draw attention to the fact that in the reproducing of works of art, for printing, there were two kinds of blocks used, line blocks, and tint blocks. With the ine block the artist can obtain a solid line, but with he tint block he had to rely on a plate which was nechanically covered with a kind of dotting. Whilst he thought these tint blocks in some cases might ustify the appellation of "criminal," he thought hat line blocks might be relied upon to give a perfect *facsimile* of the artist's work, but, of course, he had to prepare his work for such a block, and to consider the means to be used in its reproduction. With regard to the question of science, it might be aid that when Science came in at the door Art flew out at the window; though it was a sad thing to hink so. He regretted to think that some of the ine old artistic professions were almost in danger of xtinction. Perhaps in another ten years people might look back and regret that we towards the nd of this century allowed so noble and subtle n art as that of line engraving to decay. He ven-ured to think that it would not perish. One was eminded of the reply of a man when someone aid how all the professions were overcrowded:— Yes, but in every profession there is plenty of oom, at the top." So it would be in all of these tistic professions, there was plenty of room at the op. The kind of art which would cease, the art hich could be superseded, was the art of repro-ucing. These things were not original work, but ly copies. Photography had superseded copying; ut a photograph could not think, it could not invent, and the men who could do such splendid work as had been shown would undoubtedly find, when their work was trenched upon by the scientific mechanician, that, as Mr. Biscombe Gardner had done, they must produce original work. He formerly did very splendid work indeed in reproducing pictures in such a way that no English wood-engraver had approached, but photographic processes had trenched upon it, and he had now developed a style of original art, carrying out his own work. No amount of processes would improve that off the face of the earth. If gentlemen who devoted themselves to line engraving would realise that they would only be improved away, in as far as they were reproducers by mechanical methods, but could not be improved away when doing original work, it was quite possible they might find a fresh scope for their talents. They need not go further than the streets of London. If he were a line engraver and found his business was being taken away, he should go out and draw the people at the street corners, crossing-sweepers, costermongers, and the 'Arrys and 'Arriets on Hampstead-heath, and the innumerable little acts of helpfulness one sees in the streets. All these subjects were essentially modern, and they could thus produce an art which would never be out of date, and never could be extinguished. With regard to some of those beautiful things shown that night, he only expressed the universal feeling in saying how much they were indebted to Mr. Clulow for having brought before them such a splendid exhibition. He said at the commencement that he was going to limit his subject, and, of course, in an hour's paper a lecturer could only dig deeply or dig widely. If he dug deeply he could only cover a very small surface. That was what he had done, and done it thoroughly. He (Mr. Stannus) had often admired these engravings, but had never realised until this evening how perfect they were. There had been a sort of lurking suspicion in people's minds that, though they looked well on that very small scale, they would not bear magnifying; but it had been shown conclusively that they would; and he felt very much indebted to Mr. Clulow for having brought forward that side of the question.

Mr. H. B. WHEATLEY said they were much indebted to Mr. Clulow for an exhibition which was to some extent a sort of revelation. They heard a great deal of the extinction of line engraving, and they could see from these small works of the little masters, as Mr. Clulow called them, how much they had lost. He had been used all his life to these engravings, but he must express his surprise at seeing that they could be enlarged by the lantern on the screen with such admirable effect. Some of the Turners and Stothards were beyond all praise. The mode of illustrating books at the period referred to was forgotten by a great many who were not special book collectors, and who did not remember the Keepsakes and Amulets and other books of that kind, but only thought of the illustrations of the present day. It had been almost raised into a canon of criticism that copper or steel engravings were out of place in a book—that if you used an illustration with the type it must be a wood-cut. There was a great deal to be said for that view, as it was logical that raised engraving should be used with raised type, but when they looked at these books and some others which were not perhaps so well known, such as Dibdin's bibliographical books—about the finest ever produced in England or any other country—they saw how well line engravings could be used in the printed page. So that the 50 years dealt with was really a period of which they must all be proud. They could not, however, have artists of such a character without paying them very well, and they all knew that the cost to Samuel Rogers of his two volumes of "Poems" and "Italy" was a small fortune. At the same time there were occasions when some revival of this kind of work, if they could find suitable artists, might prove remunerative.

Mr. C. NAISH said anyone who alone started this subject, even with a good collection of prints, would take several months to arrive at as much knowledge as Mr. Clulow had laid before them in one hour. Like other speakers, he had been astonished at the beautiful effect of these small works when enlarged as they had been. With regard to the position of line engraving in art, there was something quite elemental in its character. It was extremely interesting to notice the place which the line occupied in Nature; you could not get away from lines, for wherever you looked in Nature you found them. It was impossible to look at the picture on the screen without seeing what a frequent use the engraver made of the spiral line. If we take a fold of drapery we see the line starting out of the shadow rather quickly, then gradually losing speed, it reaches the raised part of the fold in its nearest approach to a straight line. The more closely line engravings were examined, the more it would be seen that to the spiral line they owed a vast deal of their beauty. A very interesting question had been raised that evening as to the possibility of line engraving becoming extinct. But he did not fear this. He always thought there would be some man in some garret, with a copper and steel and an old champagne cork to serve as a handle for his graver, who would continue to make his pictures without considering whether anybody looked at them or not. He would still go on making his pictures, and some day they would be seen in their proper value, and the art would thus be preserved. He entirely agreed with the remarks made about photographic reproductive processes; they had a work to do, undoubtedly, in popularising art, but no one would expect in that room to have photography spoken of as an art in itself. Many processes had been produced, and some artists of high rank endeavoured to invent black and white processes with more or le success. He thought he might safely venture t predict that, say in the year 1945, they wou not have in that room a lecturer who would b speaking about the great beauty of the photograph process at the close of the 19th century, and throv ing on the screen enlargements 60 or 70 times the original size in order to show the great beauty their component parts.

Mr. WHEATLEY remarked that without the a of photography they could not have had the beautif pictures which had been thrown on the screen th evening.

The CHAIRMAN, in proposing a vote of thanks Mr. Clulow, said he was glad to hear someone say word for photography. It had been very truly sa that what they had seen that night was quite revelation; it certainly was to him, for though l had been familiar with these beautiful engravings Rogers's books since his boyhood, he had no id that they would bear magnifying in the way that h been shown.

The vote of thanks having been carried,

Mr. CLULOW, in reply, recommended his heare to look out for the small books, such as he h referred to in the course of the paper, which mig often be picked up at a mere nominal sum.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 19, 1897; Sir DOUGL GALTON, K.C.B., F.R.S., Vice-President the Society, in the chair.

The following candidates were proposed f election as members of the Society:—

Heys, Harry, 2, Ash-terrace, Savile-town, Dewsbur
Janson, Frederick Halsey, 60, Westbourne-terrac W.
Reed, Thomas, 63, King-street, South Shields.
Root, John, jun., Colombo, Ceylon.
Rylands, Mrs. Enriqueta, Longford-hall, Stretfor Manchester.

The following candidates were balloted f and duly elected members of the Society:—

Bird, William Frederick, Midsomer-Norto Somerset.
Fox, Edwin, 99, Gresham-street, E.C.
Harvey, E. Field, Omrac, St. John's, Newfoundlar
Moss, Charles Herbert, Thorn Bank, Rotherham.
Reeves, Hon. Sir W. Conrad, The Eyrie, Barbad West Indies.

Skaife, Wilfrid T., 630, Sherbrooke-street, Montreal, Canada.

The paper read was—

THE LONDON WATER SUPPLY.

By Dr. Percy Frankland, F.R.S.,
Professor of Chemistry in Mason College, Birmingham.

Thirteen years ago I had the honour of addressing, in this room, the members of the Society of Arts on "The Upper Thames as a Source of Water Supply," a subject, therefore, almost identical with that of my proposed discourse this evening. Now, although the London water supply is virtually the same in 1897 as it was in 1884, there is much which can be said about it to-day which was altogether unknown on the former occasion; it forms, in fact, a convenient framework on which to exhibit some of the most important advances which have been made during this period in our knowledge of the hygienic aspects of potable water. In short, although London still drinks Thames water, and is still served by seven private companies, instead of by the energetic body of reformers sitting at Spring Gardens, and who are so anxious to add this to their other responsibilities, science has moved onwards, and some of its advances ave served to throw the most important light n the intrinsic nature, but not, of course, on he politics of this great supply. The hemistry of water-supply has remained unhanged, the same methods of analysis are till employed, but another science, which 3 years ago was in its infancy, has in the nterim arrived at maturity, and has come orward to supplement our knowledge of the actors which are of importance in securing he wholesomeness of drinking water.

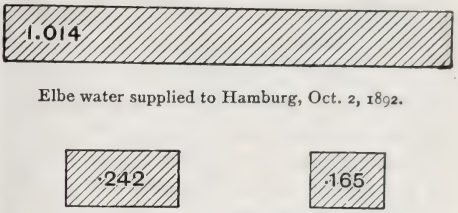
Thirteen years ago most practical men, or he apostles of what I believe is called *ommon sense*, had not only no faith in acteriology and its prophetic teaching, but hey did not hesitate to ridicule its earliest evelations whenever the opportunity offered, hilst the same men to-day talk glibly of icrobes and bacilli as of things with which hey have the greatest familiarity and the ost intimate personal acquaintance.

It is to the discoveries in this remarkable cience of bacteriology that is due the great hange which has been wrought in the opinion hygienic authorities concerning the subject water supply in general, and concerning e metropolitan supply in particular.

It is to this influence of bacteriological research on expert opinion that I beg leave to draw your attention this evening.

It is almost a matter of common knowledge that the solicitude for securing a pure water-supply is occasioned by the now indisputed fact that at any rate typhoid fever and Asiatic cholera may be communicated by water, which has received the excreta of persons suffering from these diseases, and it has been shown by the classical researches of Koch, Eberth, Gaffky, and others, that each of these diseases is due to a specific micro-organism.

Organic Matter (Carbon and Nitrogen) in Elbe, Thames, and Lea Water.



Elbe water supplied to Hamburg, Oct. 2, 1892.

Thames water supplied to London, 1891.

Lea water supplied to London, 1891.

All efforts to combat these diseases must, therefore, be aimed at banishing or destroying both these specific bacteria themselves, and those conditions which are favourable to their vitality and multiplication.

The question then arises—What becomes of these two bacterial forms which carry within them such potentiality for mischief when they gain access to water? Is the duration of their life in water long or short, do they multiply or degenerate, are they removed in the natural and artificial processes of purification to which water is subjected?

The high importance of these questions is obvious, when we take into consideration that by far the larger proportion of all natural water is liable to more or less contamination with sewage matters, which may at any time contain the morbific particles of typhoid, for that disease, like the poor, we have ever with us, and under exceptional circumstances the morbific particles of cholera may be there also. But, it will be asked, if these diseases are produced by these specific bacteria, will not bacteriology most materially and directly help us in adjudicating upon the fitness, or otherwise, of water for dietetic use, by informing us whether any particular water-supply contains these specific forms or not.

The most superficicial reflection will, however, show how illusory this suggestion is. Thus it is obvious that these specific bacteria of typhoid and cholera must inevitably be but very sparsely distributed in a water which can by any stretch of the imagination be called potable, so that even if we should ever become possessed of methods which would unerringly detect these forms in such a volume of water as can reasonably be submitted to examination, their non-discovery would possess almost absolutely no value in establishing the harmlessness of the water in question. In spite, however, of the cogency of this simple consideration, nothing is more surprising than the tenacity with which the idea clings in many quarters that the special province of bacteriology in connection with water-supply is to discover the presence or the absence of these specific disease-producing organisms. Unfortunately, this idea is not merely a harmless misconception, but leads to the circulation of mischievous statements calculated to deceive the lay public. Thus, I could put my finger on reports in which it is stated that the bacteriological examination of a particular water had failed to reveal any pathogenic bacteria, from which the man in the street is intended, of course, to draw the conclusion that the water in question is, *ipso facto*, free from danger. What should we think of a man stating that a whole county was free from poisonous toadstools because on a few square inches of its surface, which alone he had submitted to examination, he had failed to find any noxious *fungi?* But even this parallel does not exhibit the misleading character of the statement in all its nakedness, for it must be remembered, and it cannot be widely enough known, that we are at present only in possession of the most imperfect methods for detecting and identifying these pathogenic bacteria, should they even be present in the infinitesimally small quantity of water that we can submit to bacteriological examination.

Time, however, forbids that I should further emphasise that it is certainly not by discovering the presence or absence of specific disease-producing micro-organisms in different waters that bacteriology has placed sanitary science under any debt of gratitude in the past, and that it is equally unlikely that it should do so in the future. It is in quite other directions that bacteriology has rendered important services to water hygiene.

Inasmuch as nearly all surface waters ar liable, as we have seen, to more or less contamination with sewage, in which the specifi bacilli of typhoid, at least, may at any time b present, we are naturally led to ask—What wil be the fate of these bacilli in those purificatio processes, natural or artificial, to which it i now usually regarded as imperative that suc surface waters should have been submitte before they are used for drinking purposes b man?

Thus, that portion of the London suppl which is derived from the Rivers Thames an Lea has long ceased to be consumed in it crude condition, but, as you all know, i purified by storage in large reservoirs, an subsequently by careful filtration through san before it is distributed in the metropolis.

According to the latest report (February 1897), of the Official Water Examine General A. de C. Scott, the average dail supply delivered from the Thames durin the month was, 108,301,037 gallons; fron the Lea, 52,872,240 gallons; from spring and wells 26,417,799 gallons; from ponds a Hampstead and Highgate, 243,597 gallons The last is used for non-domestic purposes only The daily total was, therefore, 187,834,67 gallons for a population estimated at 5,662,774 representing a daily consumption per head o 33·17 gallons for all purposes.

The relative proportions cf the supplie from the above various sources were a follows:—

From the Thames	57·66	per cent.
From the Lea	28·15	,,
From springs and wells ..	14·06	,,
From ponds	·13	,,

Thirteen years ago there was practicall no evidence from which any conclusion coul be drawn as to the value of these purificatio processes in the removal of dangerou bacteria should they be present in the wate Such evidence as there was certainly tende to show that storage and filtration coul have but little beneficial influence in thi direction. Thus it was known that som bacteria were possessed of such remarkabl vitality that they could be kept for years i the living state, and without undergoin change, and it was, therefore, inferred b some that all bacteria were probably en dowed with similar powers of endurance.

Again, it was known that some bacteria ar capable of multiplying or reproducing them selves under favourable conditions with th fabulous rapidity indicated in the following diagram :—

Theoretical Possibility of Multiplication of a single Bacterium.

Hours.	Number of Bacteria.
0	1
1	2
2	4
3	8
4	16
5	32
6	64
12	4,000
24	16,000,000
48	280,000,000,000,000

And it was not unnatural to conclude, therefore, that a single disease-germ introduced into a suitable subject would there multiply to such an extent that the same ill-effects would result as if a thousand or a million germs had been introduced in the first instance.

Moreover, it was, of course, known that bacteria are excessively minute organisms, a square inch of surface being capable of affording standing room, if I may be permitted the expression, to 400,000,000 individuals, and this led to the conclusion that they could, therefore, pass in large numbers through the smallest apertures and channels of porous substances with the same facility that vehicles thread their way through our crowded and narrow thoroughfares.

All of these inferences have fortunately now been submitted to the test of direct experiment, thanks to the improved methods of bacteriological research available during recent years.

The urgent necessity of such direct experimental investigation being made can be best realised by bearing in mind that a Royal Commission had some time previously expressed itself on this subject of filtration in the following terms :—

> "We desire it to be distinctly understood that, although this purification of water . . . . . may reasonably be considered on theoretical grounds to be some safeguard against the propagation of epidemic diseases, there is not in the form of actual experience a tittle of trustworthy evidence to support such a view."

It was in 1885 that I turned the resources of modern bacteriological methods on to the investigation of the purification processes practised in connection with the London water supply, and during three years made regular monthly examinations for the Local Government Board of all the waters supplied to the metropolis. These examinations at once gave the most decisive and unmistakable information as to the value of these processes, showing, as they did, that on the average about 98 per cent. of the micro-organisms present in the unfiltered river-waters are removed in the treatment to which these waters are subjected before being distributed to the consumer. Thus, taking the year 1888 :—

NUMBER OF BACTERIA FOUND IN ONE C.C. OF WATER.

Month.	River Thames.	Filtered.	Reduction per cent.
January	92,000	129	99·9
February	40,000	447	98·9
March	66,000	428	99·4
April	13,000	91	99·3
May	1,900	60	96·8
June	3,500	65	98·1
July	1,070	34	96·8
August	3,000	21	99·3
September	1,740	56	96·8
October	1,130	25	97·8
November	11,700	86	99·3
December	10,600	116	98·9

These results surely enable us to unhesitatingly say that this method of purification constitutes a most material protective measure against the water-carriage of epidemic disease, and it might have been reasonably supposed that they would have afforded some considerable source of gratification to the London water-consumer, but, incredible to relate, it produced precisely the opposite effect, and the public announcement that the London waters contained any micro-organisms at all provoked such consternation and alarm that, as a matter of history, I believe the shares of the London water companies fell on the Stock Exchange in consequence of the appearance of my first report, which was in reality the bearer of glad tidings to men. It was, in fact, some years before the significance of these results was generally understood and appreciated, but by 1892 they had been accepted by every scientific witness who appeared before the Royal Commission on the London Water Supply, which was then sitting.

The purification of the metropolitan river supply consists, as I have already stated, of two distinct processes, viz. (*a*) storage ; and (*b*) filtration ; and the results to which I have referred above show the joint effect of these two processes in removing bacteria of all kinds from the water.

It is obviously of interest, however, to ascertain the individual importance of these two parts of the purification process.

The object with which large storage reservoirs have been constructed at great cost is to give the more or less turbid surface water such prolonged repose as will lead to the subsidence, as far as possible, of the suspended particles which it contains, and thus diminish the amount of work in clarification subsequently devolving upon the filter-beds.

The bacteriological effect of this subsidence of solid particles engaged my attention already in 1884, and in 1885 I showed in a paper published in the "Proceedings" of the Royal Society what a remarkable effect the subsidence of solid particles has in removing the bacteria present in the water. Thus:—

REMOVAL OF MICRO-ORGANISMS BY SEDIMENTATION.

Water agitated for 15 minutes with Chalk, and then allowed to subside:—

	Bacteria in 1 c.c.
Untreated water contained	8,000
After agitation and subsidence......	270

Removal of micro-organisms = 97 per cent.

Water agitated for 15 minutes with Coke, and then allowed to subside:—

	Bacteria in 1 c.c.
Untreated water contained	Innumerable.
After agitation and subsidence......	None.

Removal of micro-organisms = 100 per cent.

Water agitated for 15 minutes with Animal Charcoal, and then allowed to subside:—

	Bacteria in 1 c.c.
Untreated water contained	8,000
After agitation and subsidence......	60

Removal of micro-organisms = 99 per cent.

Water agitated for 15 minutes with Vegetable Charcoal, and then allowed to subside:—

	Bacteria in 1 c.c.
Untreated water contained	3,000
After agitation and subsidence......	120

Removal of micro-organisms = 96 per cent.

Subsequently, in 1892, I had the opportunity of testing the results of these laboratory experiments on the large scale at the storage reservoirs of the several London waterworks, in connection with an investigation which I made for the purposes of the Royal Commission. I will only call your attention to two examples of this subsidence, the one taking place with the water of the Thames, and the other with that of the Lea:—

BACTERIAL PURIFICATION BY SUBSIDENCE.

West Middlesex Waterworks, Barnes, Oct. 3, 1892.

	Number of Bacteria in 1 c.c.
Unfiltered Thames water from Hampton	1,437
Uufiltered Thames water after passing through one subsiding reservoir......	318
Ditto after passing through two subsiding reservoirs	177

New River Waterworks, Stoke Newington, Aug. 27, 1892.

New River Cut, above reservoir ..	677
Outlet of first reservoir	560
Outlet of second reservoir	183

The investigations which I made in 1885 on the removal of bacteria from water by the subsidence of solid particles, included also an inquiry into the bacteriological effect of the softening of water by Clark's process, my experiments being conducted both on the laboratory, as well as the industrial scale at waterworks. Thus—

Colne Valley Waterworks.

	Bacteria in 1 c.c.
Unsoftened water from well in chalk	322
Water after softening by Clark's process	4

Reduction in the number of bacteria = 99 per cent.

Artesian Well at Clyde Wharf, London.

	Bacteria in 1 c.c.
Unsoftened water	182
Water after softening by Gaillet & Huet's process	4

Reduction in the number of bacteria = 98 per cent.

These results, exhibiting, as they do, the high efficiency of the softening process in the removal of micro-organisms, are of particular interest at the present time, since suggestions have been again quite recently made to further purify the London water by precipitation with lime.

It is obvious, therefore that the process of storage alone, as practised at the London waterworks, is capable of removing a very large proportion of the bacteria originally present in the river waters themselves.

In fact, these experiments showed that the number of bacteria which the filter beds have in general to deal with, is comparatively very small. Thus:—

WEST MIDDLESEX WATERWORKS, BARNES, AUG. 12, 1892.

Number of Bacteria in 1 c.c. of Water.

Unfiltered Water from Filter Bed.		Filtered Water from Filter Bed.	
No. 1	271	No. 1	98
,, 2	851	,, 2	25
,, 3	288	,, 3	16

Unfiltered Water from Filter Bed.		Filtered Water from Filter Bed.	
„ 7	691	„ 7	17
„ 8	308	„ 8	18
„ 9	443	„ 9	27
„ 10	447	„ 10	22
„ 11	554	„ 11	65

It must not, however, be supposed that the relationship between the number of bacteria in the unfiltered and filtered waters respectively in the above Table, represents the efficiency of the sand filtration process, for in the next Table you will see that the number of bacteria in the filtered water can be brought down to figures of just the same magnitude, even when the number of bacteria in the unfiltered water is many times greater than it was above. Thus:—

CHELSEA WATERWORKS, THAMES DITTON, AUG. 20, 1892.

Number of Bacteria in 1 c.c. of Water.

Unfiltered Water from Filter Bed.		Filtered Water from Filter Bed.	
No. 1	244	No. 1	21
„ 2	2,548	„ 2	20
„ 3	381	„ 3	27
„ 4	418	„ 4	13
„ 5	855	„ 5	6
„ 6	345	„ 6	10
„ 7	751	„ 7	24

And, again:—

LAMBETH WATERWORKS, THAMES DITTON, SEPT. 30, 1892.

Number of Bacteria in 1 c.c. of Water.

Unfiltered Water.

Unfiltered Thames water from suction tank .. 6,821
„ „ „ „ „ .. 7,104

Filtered Water.

Filter Beds at New Works.		Filter Beds at Old Works.	
No. 5	6	No. 2	32
„ 6	4	„ 3	79
„ 7	8	„ 4	56
„ 8	10		
„ 9	23		
„ 10	50		

It is thus obvious that the small numbers of bacteria found in the above filtered waters are for the most part due to post-filtration sources, for it must be remembered that the filtering materials themselves are not sterile and that the walls of the under-drains, culverts, and pipes into which the filtered water passes are clothed with bacterial life.

Time does not permit that I should enter nto the mechanism whereby these sand-filters display such a remarkable efficiency in the removal of bacteria, but I have dealt with all the most recent information on this subject in a paper which I communicated a few months ago to the Institution of Civil Engineers.

The results which I have thus far brought before you clearly show that the processes of storage and filtration, as practised on the London supply, constitute two very powerful bacterial barriers which are interposed between the rivers on the one hand and the service mains on the other. Owing to these barriers it must obviously be very improbable that any particular micro-organism, whether harmful or harmless, present in the original river-water shall reach the water-consumer.

But there is another point which has to be taken into consideration in connection with these purification processes. The above figures representing the numbers of bacteria present in the raw river waters, in the same waters after subsidence, and again after filtration, refer to those harmless bacteria which are the normal inhabitants of surface water and are wholly unconnected with disease. Now the micro-organisms of disease are not naturally denizens of potable water at all, their natural habitat being the interior of the bodies of those animals on which they are parasitic, and it is surely not unreasonable to inquire whether bacteria when placed in surroundings so entirely different from those to which they are accustomed may not suffer seriously from such a radical change in their environment.

As I have already pointed out, an answer to this question cannot be expected from an examination of natural waters known to be contaminated, for such harmful or pathogenic bacteria must of necessity be present in such small number in potable water that the chance of detecting them is almost infinitesimal, the search for them in fact being as futile as the proverbial looking for a needle in a haystack. The question may, however, be approached in an experimental way by infecting waters of different kinds with such large numbers of particular pathogenic bacteria that their presence can be detected by cultivation and their multiplication or degeneration ascertained.

My first experiments in this direction were undertaken in the year 1886, and they were intended to ascertain what would be the fate of the cholera bacilli if they should gain access to waters of different kinds. The waters which I selected for the purpose were:—

(*a*) Deep well water as supplied to a part of London by the Kent Company.

(*b*) Filtered Thames water as supplied to the greater part of London.

(*c*) Ordinary London sewage.

In order to simplify the inquiry, the waters were in each case deprived of all the organisms they naturally contained, *i.e.*, they were sterilised by steaming them for a sufficient length of time, and it was only after this that the cholera bacilli were introduced into the sterilised waters. The results were peculiarly instructive, and showed how different is the endurance of this organism in waters of different composition. Thus, in the sewage it was found to be still alive after eleven months, whilst in both the Thames and deep-well waters it did not maintain a livelihood for more than a fortnight or three weeks.

In similar experiments, conducted by other investigators on the typhoid bacillus, it was found that in sterilised drinking water this bacillus is able to maintain itself in a living condition up to 80 days in some cases. So that the typhoid bacillus can apparently make itself more at home in our ordinary potable waters than can the bacillus of Asiatic cholera, although its longevity is by no means as great as the ordinary harmless bacteria which are normally present in natural waters.

The comparatively short duration of the vitality of cholera and typhoid bacilli when introduced into water is, doubtless, due to the fact that neither of these organisms are known to occur in those hardy and difficultly destructible forms known as *spores*. In order to investigate the behaviour, in water, of a pathogenic organism which forms spores, I selected the bacillus of anthrax, which is the cause of the malady so fatal both to man and many of the lower animals. This bacillus and its spores I introduced into ordinary London water (filtered Thames water) and into London sewage, both of them previously sterilised so as to simplify the investigation—

VITALITY OF ANTHRAX BACILLI AND SPORES IN VARIOUS WATERS.

	Number present in 1 c.c. of water.	
	London Sewage.	Filtered Thames.
1st hour........	753	340
2 days	39	230
5 days	82	67
12 days	—	81
21 days	2,041	—
40 days	—	75
61 days	5,543	100

The spores of this bacillus would thus appear to possess almost unlimited vitality in potable water, whilst in sewage the bacillus underwent extensive multiplication.

In the experiments to which I have hitherto referred, the pathogenic micro-organisms were introduced into sterilised waters, so as to avoid the complications arising from the simultaneous presence of the numerous other bacteria which ordinary waters contain in their natural state. It is obvious, however, that if we are to fully ascertain what actually takes place when such pathogenic bacilli are discharged into natural waters, we must pursue the investigations under conditions approaching as closely as possible those which exist in nature. One of the most important of these natural conditions is unquestionably the simultaneous presence of other bacteria which have their habitat in water. We will restrict ourselves to the same micro-organisms which we have already referred to, viz., the bacilli of typhoid, cholera, and anthrax. A large number of experiments in this direction have been carried out, but in consequence of the extreme difficulty of the problem, the results must in some cases be received with caution.

Experiments of this kind with anthrax are of particular interest, since, in this case, owing to the susceptibility of the lower animals to this malady, it is possible to ascertain not only how long this organism can maintain its vitality in water, but also whether and how long it preserves its virulence in this medium under different conditions. Thus I would call your attention to the following experiments which I made some years ago for the Royal Society Water Research Committee (Proceedings Roy. Soc., p. 53, 1893).

VITALITY OF ANTHRAX AND ITS SPORES IN THAMES WATER.

	Natural State.	Sterilised by Steam.	Sterilised by Filtration through Porous Porcelain.
1st day	..	35	65
5th day	..	81	112
47th day	..	..	135
68th day	..	28	55
91st day	..	41	..
104th day..	anthrax just discoverable by cultivation.	..	44
7 months....	—	+	+

— Signifies that the water did not kill mice by inoculation. That the anthrax was not extinct in this was proved by adding broth to the water, and then inoculating mice, which died.

+ Signifies that the water killed mice by inoculation.

The same waters, but exposed to sunshine (151 *hours*).

7 months ..	—	—	—

The anthrax was extinct in all these three waters which had been exposed to sunshine, for on adding broth to the waters, so as to give an opportunity for the revival and multiplication of the organism, and subsequently inoculating mice, the latter did not die.

From the above Table it will be seen how the anthrax spores remained alive in practically undiminished numbers in the sterilised Thames water, whilst in the same water unsterilised anthrax was barely discoverable by cultivation, after 104 days. Again, as regards virulence, the sterilised water proved fatal to mice even after seven months, whilst the unsterilised on inoculation into mice failed to kill; on the other hand, it was found possible to revive the virulence of the anthrax by adding nutritive broth to the unsterilised water, for after doing so the water became again fatal to mice on inoculation.

Similar waters containing anthrax, which, however, had been exposed to 151 hours sunshine during these seven months, were found not only to have lost their virulence, but the virulence could not be restored by the addition of broth. These experiments furnish a good example of the bactericidal action of sunshine on micro-organisms suspended in water.

I have made also a number of experiments on the vitality of the typhoid bacillus in both sterile and unsterile waters, and I would specially call your attention to one series, in which I simultaneously introduced the same number of typhoid bacilli into Thames water, into Loch Katrine water, and into deep-well water, so as to be able to institute a comparison between these three different types of water as regards their power of supporting the typhoid bacillus in a living state (Proc. Roy. Soc. 56, 1894).

These experiments are summarised in the two following Tables.

The principal points which I would emphasise in connection with these results are—

1. That in none of these three types of potable water did the typhoid bacillus exhibit multiplication, but on the contrary, in each case there was more or less rapid numerical decline of the bacilli.

2. That in the case of the surface waters (Thames and Loch Katrine) the longevity of the typhoid bacilli was much greater in the sterilised than in the natural samples. In the case of the subterranean water (deep well), on the other hand the duration of life was practically the same in the sterilised as in the unsterilised samples.

3. In the sterilised waters the longevity of the typhoid bacillus was greatest in the Loch Katrine, and least in the case of the deep-well water. On the other hand, in the unsterilised waters the duration of life was most protracted in the case of the deep-well water, and most curtailed in that of the Thames water.

COMPARATIVE VITALITY OF TYPHOID BACILLUS IN THAMES, LOCH KATRINE, AND DEEP-WELL WATER.

(*A.*) *Waters Sterilised by Steam before Infection.*

Water.	Numerical Behaviour of Typhoid Bacillus.	Number of days after Infection on which Typhoid Bacillus was last discovered in Water.
Thames	No multiplication, but steady diminution.	32 days.
Loch Katrine..	Ditto.	51 days.
Deep Well....	Ditto.	20 days still present. 32 days absent.

(*B.*) *Waters in Natural Unsterilised Condition.*

Thames	....	9 days still present. 13 days absent.
Loch Katrine..	....	19 days still present. 33 days absent.
Deep Well....	....	33 days present. 39 days absent.

These results distinctly indicate the greater danger attending the access of typhoid bacilli to subterranean than to surface waters. This danger is, in ordinary practice, further enhanced by the fact that well water is invariably consumed without storage, whilst surface waters are often stored for days or even weeks, and in the case of moorland water the storage frequently extends over many months.

From other experiments which I have made, and which time prevents my describing, I am of opinion that the greater bactericidal power of the unsterilised surface waters is not due so much to the multiplication of the common water bacteria, leading to a competition or "struggle for existence" between these aquatic forms and the typhoid bacilli, but rather to the circumstances that these surface waters have already supported countless generations of aquatic bacteria, which have doubtless elaborated products inimical to the welfare of the typhoid bacilli, and it is quite possible also that such surface waters contain similarly prejudicial substances, which have been generated by other vegetable life present in them. Such surface waters, in fact, are frequently in such a condition that the ordinary water bacteria will not multiply in them, whilst, after sterilisation, in which process these products are doubtless destroyed, the abundant multiplication of aquatic forms becomes possible.

Deep-well water, on the other hand, is drawn from its subterranean source in an almost perfectly sterile condition, and has never since its exhaustive filtration through the porons strata of the earth, in which it has altogether altered its chemical composition, harboured any micro-organisms or other vegetable life at all, so that the abunndant bacterial multiplication which takes place in it when it is stored in the laboratory, is really the first time that it is subjected to the influence of bacterial growth, and it takes a correspondingly longer time therefore for the conditions inimical to the typhoid bacillus to be established in it.

I may mention that somewhat similar experiments to those which I have already described with typhoid bacilli have more recently been made by Hoeber ("Centralblatt für Bakteriologie," 17, 1895, p. 443) with cholera bacilli. In these experiments the cholera bacilli were introduced into aquaria so as to secure the normal conditions existing in surface waters. The result was very decisive, the cholera bacilli being no longer recognisable after the tenth day from their introduction.

These experiments show how the unsterile conditions prevailing in surface waters are actually a source of safety, militating as they do against the protracted vitality of pathogenic organisms which may become imported into them. They indicate, also, how such surface waters may be rendered more safe by artificial means, viz., by subjecting each water to the most prolonged storage possible, and thus protracting the period of operation of these bactericidal agencies. It is almost unnecessary to say that no fresh importation of contaminating matter must take place during this storage if it is to afford any guarantee of security. Such prolonged storage of surface water is obtained in natural lakes, which are, however, rarely sufficiently protected from further contamination, and in the great artificial reservoirs, with which waterworks drawing from surface sources in this country are almost invariably provided, but which not infrequently require extending.

It will thus be seen that the bacteriological processes going on between the moment of contamination of a river water, like that of the Thames or the Lea, and the distribution of that water to the consumer, are both numerous and complex, consisting as they do of—

1. Continuous destruction of pathogenic forms through the marked bacteriological influence of surface water.
2. The prejudicial influence of light on bacterial life which makes itself felt until the water passes through the sand-filter and is withdrawn from this influence.
3. Subsidence of bacterial life during the sojourn of the water in the storage reservoirs.
4. Removal of bacteria in the process of sand-filtration.

From the mass of experimental evidence, which I have now brought before you with regard to the fate of pathogenic micro-organisms gaining access to water, I think it must be conceded that unless they are present in very large numbers indeed, they will have but little chance of leaping the barriers imposed by storage and filtration provided these processes are properly carried out. That, in the absence of such methods of purification, a river highly contaminated with sewage may distribute cholera and typhoid amongst its consumers is amply attested by the experience gained in the case of the Seine at Paris and the Elbe at Hamburg. Although these instances are, doubtless, well known to most of you, they are of such importance that I would venture to briefly refer to them here.

The Seine at Paris is an excessively polluted stream, in which it is alleged that bacteriological examination has occasionally been successful in actually demonstrating the presence of typhoid bacilli. The Seine, however, does not furnish the regular domestic supply of Paris, but in times of drought, when the ordinary pure water-supply fails, it has been turned into the mains of some of the districts, with the result that a typhoid epidemic in these particular parts of the city has generally followed. Now the Seine water, which thus stands convicted of having very probably caused this mischief, it is interesting to note was not submitted to any process of filtration before delivery to the consumer.

Still more striking was the experience gained during the memorable cholera epidemic of 1892, at Hamburg.

The water which was then supplied to Hamburg, was taken from the Elbe in its tidal portion, and was thus fouled with the sewage of Hamburg itself, and this water was distributed to the city without previous filtration. In the autumn of the year in which the epidemic occurred, I had occasion to analyse a sample of this water supplied to Hamburg, and I will endeavour, by means of the following diagram, to give you some idea of its excessively polluted nature.

There is, as you know, the strongest evidence that this unfiltered Elbe water was highly instrumental in distributing the fatal malady amongst the inhabitants, and of the greatest interest in connection with our inquiry, is the circumstance that the town of Altona, which is absolutely contiguous to Hamburg, also drew its water supply from the Elbe, somewhat lower down, and where the river is, therefore, even still more contaminated, but in this case, the water was submitted to sand-filtration, before delivery to the consumer. The following are the statistics, for which I am indebted to Dr. Fraenkel of Hamburg, concerning the epidemic in these two places:—

STATISTICS OF CHOLERA EPIDEMICS IN HAMBURG AND ALTONA (1892).

	Cholera.	
Population.	Deaths.	Cases.
Hamburg—		
640,000	8,000	18,000
per 100,000	1,250	2,812
Altona—		
143,000	316	516
per 100,000	221	361

Average death-rate from all causes in 1891:—
Hamburg, 23·5 per 1,000.
Altona, 25·3 per 1,000.

The number of cases per 100,000 inhabitants in Altona was thus about one-eighth of the number for the same population in Hamburg. Without by any means laying undue stress on these comparative figures, I think it must be admitted that they furnish most important evidence of the hygienic value of the process of sand-filtration.

It may be argued, however, that if the absolute and entire removal of pathogenic forms is not wholly guaranteed, the value of the purification process is really very small, and that as much harm may be done to the individual by a few pathogenic bacteria as by a large number, since they have the power of multiplying indefinitely under favourable circumstances, *e.g.* in the system of an animal on which they are parasitic. On this point we have now, fortunately, more precise information than we had some years ago, when almost everything connected with the subject of infection was merely a matter of speculation resting upon the slenderest foundation of experimental fact.

The following experiment, made with a pathogenic organism known as *Proteus vulgaris* (Hauser), will serve to illustrate this point. Mr. Watson Cheyne, F.R.C.S., found that a rabbit or guinea-pig inoculated with a considerable dose (0·1 c.c.) of a pure culture of this organism was killed in from 24-36 hours. On inoculating a smaller dose (0·025 c.c.) of the same culture, an extensive abscess was produced, which generally caused the death of the animal in from six to eight weeks. A smaller dose than the latter, gave rise to a less serious abscess, which the animal survived, whilst a very small dose produced no visible effect whatever. By approximately determining the number of bacilli in each of the above doses he found 9,000,000 bacilli or under were innocuous; 9,000,000 to 112,000,000 bacilli produced an abcess; 225,000,000 bacilli and upwards caused rapid death.

In the same way Pasteur has shown that very minute quantities of the spinal marrow of rabid animals do not produce rabies on inoculation; and again, Arloing, Cornevin, and Thomas have shown that when anthrax virus is inoculated into some animals in very small quantities, it gives rise only to a mild and non-fatal malady, conferring subsequent immunity. whilst, conversely, Chauveau has shown that very large doses of anthrax virus may overcome the natural immunity which Algerian sheep enjoy in respect of this disease.

The application of these experimental results to the matter in question is sufficiently apparent, for by analogy it is obvious that the chance of infection with typhoid, for instance, is *totally* dfferent, and not only *proportionately* different, according as a gallon of water contains, say, one typhoid bacillus, or 1,000 of these bacilli. It is, unfortunately, impossible, in the case of typhoid, to go much beyond analogy, inasmuch as this disease appears to be altogether unknown in veterinary medicine. It is, however, highly significant that the only way in which animals can be made to artificially succumb to typhoid is by the inoculation of large doses of the virus, small doses being quite ineffectual. It is, in fact, the typhoid bacilli in the presence of the toxic chemical products to which they give rise, that cause the mischief. There can be little doubt, therefore, that quantity of virus is a very important factor in the communication of typhoid.

With regard to the quantity of typhoid virus which can be present in the waters of the Thames and Lea as they reach the intakes of the metropolitan works, some interesting calculations were made by the recent Royal Commission, and the result is well worthy of consideration in connection with the facts to which I have been referring. Thus, it appears, from Tables supplied by the General Register Office, that the annual mortality from typhoid in those counties which practically form the water-basins of these rivers has varied between 1881 and 1891 from 154 to 84 deaths in the Thames basin, and from 13 to 19 in that of the Lea. It is generally reckoned that for every death from typhoid there are 6-7 cases of the disease; so that an estimate may be made of a maximum of 1,001 cases in the Thames valley above Molesey, and 195 in the Lea valley above Chingford. Let it be supposed that all the discharges of all these cases pass directly into the rivers, and let us see to what extent they would, in that event, undergo dilution; and, in so doing, let us assume the worst possible combination of circumstances, viz., that the years of greatest typhoid prevalence coincide with the years of smallest flow in the rivers. Taking the smallest annual flow of the Thames at 294,792,000,000 gallons, this would give, in round numbers, one case of typhoid to 294,000,000 gallons of water, an amount which perhaps may be more readily apprehended if described as a mass 5 miles in length, 100 yards in width, and 6 feet in depth. A similar calculation made for the Lea gives for each typhoid case a body of water 3 miles in length, 100 yards in width, and 6 feet in depth.

In this calculation it has been assumed not only that the mortality was at its highest, and the river flow at its lowest, but that all the discharges of the infected persons passed directly into the river. This latter assumption is, of course, ridiculous; the amount that can be supposed actually to pass in cannot possibly be more than an excessively minute fraction of the whole. (Report of the Royal Commission appointed to inquire into the Water Supply of the Metropolis, 1893, p. 59.) "Altogether we are led to the conclusion, from the evidence put before us, that the amount of active specific typhoid poison that can get into the Thames or Lea, whether under ordinary condition or in time of flood, is infinitesimally small when put into comparison with the enormous volume of water with which it will be diluted." (p. 60.)

It is obvious, also, that in the passage through a river and during prolonged storage in a reservoir, such typhoid bacilli as might be originally present would become thoroughly separated from their toxic chemical products, which, from the experiments on the lower animals already referred to, so greatly assist them in their attack.

It will be interesting now to inquire as to whether there is any evidence afforded by the Typhoid Mortality Statistics of the communication of this disease by the present London supply. This inquiry has been facilitated through the compilation of a most interesting Table by Dr. Shirley Murphy, the Medical Officer to the London County Council, in which the mortality from typhoid in London is compared with that in a number of English towns in which the water-supply is stated to be altogether above suspicion, *i.e.*, "not excrementally polluted":—

AVERAGE ANNUAL ENTERIC FEVER DEATH-RATE (1881-90) PER 10,000 INHABITANTS.

	Population, 1891.	Average.
Portsmouth	160,128	4·9
Blackburn	120,496	4·1
Preston	107,864	3·8
Salford	198,717	3·8
Nottingham	369,099	2·9
Cardiff	130,283	2·8
Derby	94,496	2·6
Hull	200,934	2·5
Liverpool	517,166	2·6
Birkenhead	95,597	2·1
LONDON	**4,221,056**	**1·9**
Brighton	115,606	1·8
Bradford	216,938	1·7
Bristol	213,874	1·5
Huddersfield	95,66	1.5

The brief outline of facts which I have so far brought before you clearly shows that the treatment which the river waters undergo before they are supplied to London is capable of purifying these waters in a highly remarkable manner, and that the efficiency of this purification is proved by direct experiment to be far greater than could have possibly been anticipated on *a priori* grounds. It would, however, be dealing with the subject most unscientifically, and in a manner quite unworthy of this place, to let the matter rest here without inquiry as to whether these purification processes really do go on with the same degree of efficiency from one year's end to the other. Now in the monthly examinations of the London waters which I made during the years 1886, 1887, and 1888, there were two conspicuous occasions on which exceptionally large numbers of bacteria were found in some of the filtered waters, and on both occasions this disturbance coincided with a very low temperature of the river water. The accompanying diagram (Fig. 1, p. 622)* exhibits, on the one hand, the temperature of the Thames water on the days on which samples were collected, and, on the other hand, the average number of bacteria found in the filtered water of the five Thames companies collected on the same day. From this diagram it will be seen that in January, 1886, and in January, 1887, the average number of bacteria found in the filtered waters was very large, and in both cases it will be observed that the temperature of the river water at the time was in the vicinity of the freezing-point. On one other occasion, viz., in March, 1886, the temperature of the river water closely approached the freezing-point, and on this occasion the number of bacteria in the filtered water was also large, although not so excessive as on the two above mentioned.

With so low a temperature of the water in the river, it is highly probable that the water on individual filter-beds was actually frozen. The presence of ice on the filters is well-known to be one of the most serious troubles incidental to sand-filtration, the removal of the ice involving sometimes the employment of large numbers of men, and it is easy to understand how in this operation the surface sand, which is the most important part of the whole bed, may become disturbed, with the result that the efficiency will be impaired. Again, if the frost actually gain access to the sand it is obvious that serious disturbance must take place, for through some of the filter-beds becoming choked with ice it will become necessary to filter at a greater rate through those beds which still remain open, with the result that an inferior filtrate will be obtained. In the critical age in which we live it is perfectly futile to gloss over defects of this kind, either by attempting to conceal the facts, or by endeavouring to explain them away by means of specious arguments, and by authoritative statements.

It is, in fact, a matter in which the inhabitants of the metropolis should absolutely set their face against anything in the shape of special pleading. Such special pleading is not fair to those conscientious men, the engineers of the companies, who, fully realising their great responsibilities, are straining every nerve to give London the very best supply of water which lies in their power; and I feel sure that it is only necessary to call their attention to the imperative necessity of facing and dealing with this periodical difficuly which presents itself in connection with the existing purification processes, in order that it shall be speedily overcome. For that this difficulty can be overcome has been demonstrated by the experience gained at the Altona, and at the new Hamburg waterworks, where a very inferior raw material and much more unfavourable climatic conditions have to be reckoned with.

But if the educated public of to-day is averse to *ex parte* statements on behalf of the present supply, it must surely also repudiate an unwarrantable condemnation of this supply. An attack has, as you are aware, recently been made by the London County Council, a body which, as we all know, believes one of its many missions to be the execution and management of public works. The impeachment is contained in a document bearing the title, "Analytical Investigation of London Water Supply." The only part of it which is germane to the matters which I have brought before you this evening consists of certain reports presented to the Council by four experts, Mr. Dibdin (Chemist to the Council), Dr. Dupré, Dr. Klein, and Dr. Stevenson.

I need not make any special reference to the reports of Drs. Dupré and Stevenson, for these gentlemen found nothing very remarkable in the samples of water which they examined, and they only publish a few figures which admit of comparison either with those of their colleagues or with those obtained by other observers. I must, however, enter a public protest against the bacteriological standards by which they undertake to adjudicate upon potable water.

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* Fig. 2 shows how it is in the winter months; also that the largest number of bacteria is found in the unfiltered river waters themselves.

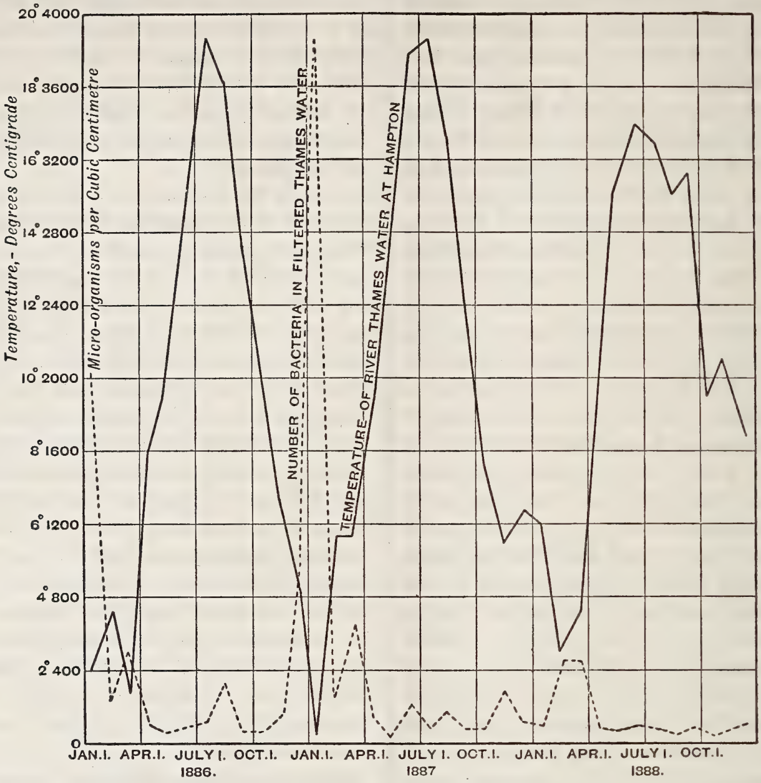

Fig. 1.—Relationship between Temperature of Thames Water and Number of Bacteria in the Filtered Thames Water supplied.

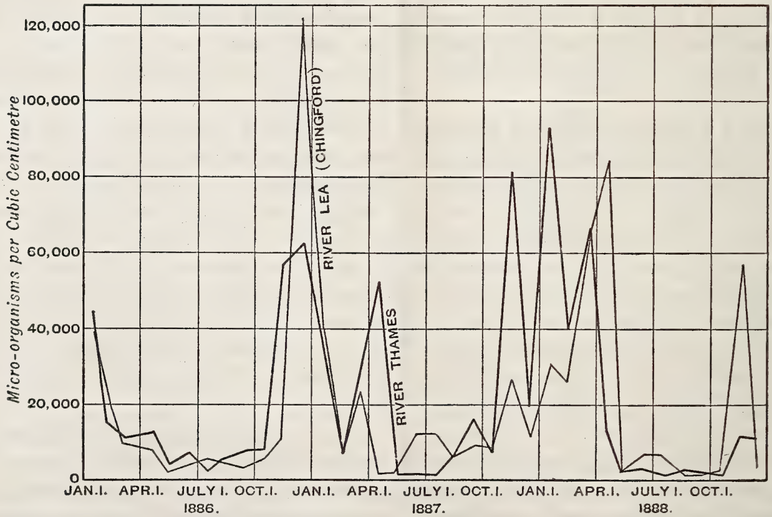

Fig. 2.—Monthly Bacteriological Determinations of Unfiltered Water from the Rivers Thames (Hampton) and Lea (Chingford).

Thus Dr. Dupré says: "Taking the number of these organisms permissible in a drinking water at 100 per cubic centimetre, as fixed by Professor Koch, not less than 35 (samples) out of the 64 (examined) exceeded this limit." Again Dr. Stevenson says: "I adopt 100 organisms per 1 cubic centimetre as the maximum number permissible in a good drinking water, taken from a river and efficiently filtered." Both of these gentlemen thus put upon Dr. Koch the responsibility of judging these samples by a standard made in Germany and which like some other commodities coming from that country it would be desirable to exclude from our shores. The worthlessness of standards of purity has long since been demonstrated in the case of the chemical examination of water, and all who have had a sufficiently prolonged and varied experience in its bacteriological examination have come to recognise that bacteriological standards are equally fallacious and unscientific. Having myself never for a moment been captivated by such standards of bacteriological purity, it has afforded me no little entertainment and satisfaction to notice how others who have adopted these standards during their bacteriological noviciate have found themselves compelled to publicly retract or explain away their previous statements in this connection. It is particularly noteworthy that in the reports of Drs. Dupré and Stevenson, even the Kent Company's deep-well water, the purity of which has hitherto failed to find an assailant, does not escape condemnation by this inspired standard, and I should very much like to know whether these gentlemen, with their long experience of the sanitary aspect of water-supply, an experience which I have no hesitation in saying is far more extended than that of Dr. Koch, I should like to know, I say, whether they really think seriously of this Kent Company's water, on the occasions when it does not comply with this standard, and whether they would be kind enough to name some other water which could be consumed with greater safety.

They are, however, the reports of Mr. Dibdin and Dr. Klein, which admit of most comment, for they have given their bacteriological figures in such detail as to enable a comparison between them to be instituted.

The following are the figures given by Mr. Dibdin for the year 1895.

With these figures I have no fault to find, they are in substantial agreement with the results which I had obtained with the same waters nine years previously; they indicate, moreover, I may incidentally mention, that the waters were undergoing almost uniformly efficient bacteriological purification throughout the year.

It is unfortunate, however, that Mr. Dibdin publishes the following average results, which he obtained in 1891-2:—Kent, 4,795; Southwark, 4,594; Lambeth, 4,626; Chelsea, 3,091; Grand Junction, 2,612; West Middlesex, 2,534; New River, 2,299; East London, 3,387; Sunbury, 179,601.

Now whilst I have no hesitation in accepting the previous Table, I am equally confident that these figures do not represent the average numbers of bacteria present, either in the river or in the waters distributed in the companies' mains over an entire year. They might have been present during exceptional weather in winter, but they are not averages for the whole year, 1891-2, either as regards the raw or the filtered river water, as, from the wording of the report they purport to be. I would, however, again point out that, large as the figures are, they indicate a removal of from 97·4 to 98·6 per cent. of the bacteria in the purification processes to which the Thames water was submitted.

But Mr. Dibdin draws conclusions from these two series of figures, for he says that they furnish "reliable data for comparison as to

NUMBER OF BACTERIA PRESENT IN ONE C.C. OF WATER.

Month.	Kent.	Southwark.	Lambeth.	Chelsea.	Grand Junction.	W. Middlesex.	New River.	E. London.	Unfiltered Mains at Sunbury.
January	89	838	793	127	111	128	274	395	15,135
February............	80	545	131	161	201	92	194	318	29,308
March..............	122	818	238	165	135	294	251	556	29,844
April	135	325	286	188	253	135	114	151	7,080
May................	73	170	88	339	284	142	145	78	5,664
June	92	199	204	158	181	231	83	602	16,013
July................	79	142	102	95	263	113	83	163	10,774
August	112	164	838	108	119	96	98	123	4,813
September	31	164	124	71	113	80	44	88	2,884
October	40	78	59	61	43	54	56	76	9,900
November	139	427	366	55	169	65	92	494	45,263
Average	90	352	294	139	170	130	130	277	16,061

the bacteriological improvement which has taken place in the quality of the water between the years 1892 and 1895." This improvemant he attributes to greater care exercised in the filtration, but he appears not to have noticed that, according to his figures, the Kent Company's water, which is derived, as you know, from deep wells in the chalk, and is not artificially filtered at all, has improved to a still more marvellous extent. Does he wish the reader to infer that even the chalk strata have been pulling themselves together, and removing the microbes more perfectly through fear of the London County Council?

When Mr. Dibdin says that these figures constitute "reliable data," it is impossible not to envy him the possession of the optimistic disposition which can be so easily satisfied.

Still more remarkable are the figures published in Dr. Klein's report. Dr. Klein informs us that he examined 64 samples of water during the winter of 1894-5, many of these samples (about the latter half) were, therefore, coincident as regards time of collection with some of the samples examined by Mr. Dibdin, and it becomes of interest to compare the results obtained by these two independent observers.

A glance at the following tabulated results will show you, that, where Mr. Dibdin found hundreds of bacteria, Dr. Klein succeeded in finding thousands, whilst the fluctuations amongst his own results are no less remarkable than the discrepancy between his figures and those of Mr. Dibdin.

Number of Bacteria present in One c.c. of Water.

Name of Water Company.	1st week.	2nd week.	3rd week.	4th week.	5th week.	6th week.	7th week.	8th week.
West Middlesex	248	320	3,796	1,284	10,880	508	9,472	51,040
East London	168	288	1,648	984	420	34,816	100	108
Kent	2,684	1,844	1,772	5,508	684	124	592	20,576
Lambeth....................	260	208	1,444	16,160	676	116	48,512	7,424
New River..................	19,200	84	1,932	1,360	92	656	14,000	24,496
West Middlesex	17,920	21,600	3,904	1,156	1,512	20	1,580	7,272
Chelsea	16	616	24,148	2,124	21,408	264	15,264	420
Grand Junction..............	96	156	33,600	2,568	52	1,812	948	16

But here again, they are the results obtained with the Kent Company's water, which most effectually shake our faith in the trustworthiness of the figures. In five out of eight samples of the Kent Company's water examined by Dr. Klein, he finds upwards of 1,000 bacteria in the cubic centimetre, and in one sample the number actually exceeds 20,000. How is it to be explained that, if such a dense bacterial population was really present in this water, it entirely escaped the observation of Mr. Dibdin?

But the startling novelty of Dr. Klein's discoveries, embodied in this Table, can only be exceeded by the confidence with which he puts forward his conclusions based upon these figures.

"From this Table," he says, "it will be seen that the number of bacteria per 1 c.c. was in very few instances below 100, *this latter being the number above which the micro-organisms in drinkable water should not rise*" (the italics are mine). He then catalogues the few instances in which the number found was less than 100, and goes on to say, "The other samples must be considered as containing a superabundance of microbes."

I can only assure Dr. Klein that neither these figures, nor his *ipse dixit*, will ever convince those who have even the most elementary acquaintance with the London water supply that the Kent Company, on those eight occasions on which his samples were collected, was sending out "undrinkable" water, nor will those who have a little more detailed knowledge of the subject give any credence to his statement that the waters of the West Middlesex and Chelsea Companies "are conspicuous by the excessive numbers of bacteria" which they contain, for these are the very waters which have been, over and over again, shown to be the least densely populated with bacterial life.

The publication of such flagrantly contradictory reports as those to which I have just referred are not so much to be regretted on account of the injustice which they do to the present London water supply, for the discrepances which they exhibit, and the fallacious arguments in which they abound, led to their immediate public condemnation by all who have acquaintance with these matters. But I, personally, do deeply regret the issue of this document, as it must tend to bring public discredit upon a method of water examination, the value of which it has taken years of patient labour to establish.

From the account which I have given you of the bacteriological labours which have been lavished on the subject of water-supply during the past 13 years it will be seen that an enormous amount of new and important information touching the hygiene of water has been collected during this period. This new knowledge has wrought a great change in expert opinion throughout the world, and this change of opinion has been greatest in respect of precisely that type of water which constitutes the major part of the present metropolitan supply, viz., river water which has been subjected to storage and filtration.

This bacteriological investigation has shown that river waters by suitable storage and filtration can be rendered of excellent quality for the supply of towns, and that the extent to which such surface waters can be deprived by means of these processes of their bacterial life is altogether beyond what was to be expected.

Careful search has also revealed the mechanism by means of which this remarkable purification is effected; it has shown what dangers this mechanism is exposed to, how these dangers may be guarded against, and how the efficiency of the mechanism may be maintained and even improved.

Bacteriology has thus become of priceless value to the water engineer, indicating the measures which must be adopted to secure the best possible result with the material at his command, and it justifies him in the execution of those costly works in which every zealous water engineer delights, by enabling him to demonstrate with a concreteness not before possible the hygienic utility of his projects.

But bacteriology has also furnished the public with a means of control, whereby almost the slightest negligence on the part of the water engineer can be detected, and almost the slightest irregularity in the purification processes exposed.

That this new and delicate method of examination is liable to abuse and that its results are capable of misinterpretation is not surprising; it has, of course, like all the other delicate instruments which science has devised, *les défauts de ses qualités*. But that does not detract from its value, for surely, in the same way, it would be hypercriticism indeed to find fault with the chemical balance because its delicacy renders it useless in the hands of a greengrocer or coalheaver.

The bacteriological investigator is generally regarded as a bird of ill-omen; he was certainly so regarded by the advocates of the present metropolitan supply when he first made his appearance. He was, however, in reality a friend in disguise, and I think there can be no question that they were his revelations which called forth the dictum from the late Royal Commission:—

"We are strongly of opinion that the water, as supplied to the consumer in London, is of a very high standard of excellence and of purity, and that it is suitable in quality for all household purposes."

DISCUSSION.

Mr. **Brudenell Carter**, F.R.C.S., said that he should be glad if Dr. Frankland could favour them with a little further information on one point, viz., the cause or causes of occasional imperfect filtration. If he remembered rightly, Dr. Koch, when dealing with the purification of the water at Altona and Hamburg, pointed out that sand-filter beds did not arrive at a perfect condition until they had been for some time in use, and that the efficient agent in the removal of bacteria was not so much the sand itself as the slime which was formed on the upper surface. If that were so, it would appear that there should be some criteria by which the quality of the water which had passed through a filter in its initial stages could be tested, and that in certain conditions such water should be re-filtered. Mr. Shirley Murphy published a curious statement in two successive reports, in which he showed that in December of two successive years there had been a certain sprinkling of typhoid fever all over the metropolis, which he showed by red dots on a map. The cases were not numerous, but they were slightly in excess of the average, and they followed, at the natural period of typhoid incubation, the flooding of the Thames and the Lea. It seemed as if the method of filtration, which was sufficient for dealing with the ordinary amount of sewage contamination, had in some way failed to deal with an unusual amount of such contamination. Mr. Shirley Murphy did not put this forward as indicating any real or serious danger, but rather compared it to the danger to a railway passenger of getting into an accident; but still it seemed to call attention to what might possibly be a weak place in the purifying arrangements, and he should be glad to hear what Dr. Percy Frankland thought of it. He presumed he agreed with Dr. Koch that the rate of filtration was a matter of importance.

The CHAIRMAN said Dr. Percy Frankland recently read a most interesting paper, at the Institution of Civil Engineers, on the subject of filtration, in which he dealt with some of the points just alluded to. They must all feel great satisfaction in thinking that the water supply of London was really excellent, notwithstanding the criticisms that had been passed upon it. They were quite certain, from the numerous experiments of Dr. Frankland and others upon the bacteriological conditions of water, that storage and filtration did, in fact, give a very excellent supply, and he hoped this knowledge would be taken to heart by Londoners before they committed themselves to expensive schemes for bringing water from more distant regions, such as the Welsh mountains. Those sources of supply, though they were excellent, belonged partly to other parts of the country, and he thought they ought to utilise the water which was available at hand before going so far afield. Engineers always liked to execute works of an important nature, and were not always content to utilise methods which were ready to hand, but were less grand and pretentious. He hoped, therefore, that this paper would lead to more discussion outside than it seemed likely to elicit on that occasion.

Dr. DUPRÉ, F.R.S., said he had very recently given his opinion on the London water supply, and he so heartily agreed with much that Dr. Frankland had said that, if he had not finished by making unnecessary attacks upon others, he should have said nothing at all. He was very glad to hear two statements: first of all, that it was a fallacy to suppose that bacteriology could be relied on as a test for water. As Dr. Buchanan pointed out long ago, it could show danger, but could not show safety. In the next place, he was glad to hear Dr. Frankland state that the number of 100 in one c.c. was entirely independent of the number of bacteria in the water. It was a fallacy to say that by filtration you reduced the number by 90 per cent. or 99 per cent.; a good filter filtered out everything, and the bacteria found in the filtered water were not those which were left in, but those derived from the material of the filter or below it. The number 100 was only of value because a good filter, in proper action at a given rate, ought not to show more than 100; it was merely a guide as to whether the filter was acting properly; if there were more, the filter was either foul, or inefficient. As Dr. Frankland had attacked his paper, he must say a word or two about it. In the first place he had never by written or spoken word in any way qualified his report; he adhered to every word of it, and to show how little it was necessary to qualify it, he might quote a few figures though he had not the paper with him, as he did not know it was to be referred to. The number of times Dr. Frankland found more than 100 bacteria in the water amounted to 37 out of 64, or rather more than half, but he (Dr. Dupré) only found one quarter with more than 100; so that he found fewer samples containing above 100 than Dr. Frankland. But Dr. Edward Frankland found as many as 5,000 on one occasion, and 2,000 on another, and his samples were taken at the Company's works, whilst he (Dr. Dupré) took his from the standpipes in London. Therefore, so far from over-estimating the numbers, he had apparently under-estimated them. In the next place, Dr. Percy Frankland had given only the good results, not the bad ones; but in such a case as this it was a mistake to take the best, or even the average results, you ought to go by the maximum, not the minimum, the former being the measure of safety. Taking Professor Edward Frankland's report for December, he found in one case 16,000 colonies, and 2,000 in another. That was sufficiently alarming, but the explanation given was almost more alarming. He stated that the filter had only been in use a short time, and was discontinued soon after. In another case he said this filter-bed had only been in use 12 hours, and had not yet reached its natural efficiency. He had always pointed out that it was not when the filters were at their best, or even the average, but the maximum that you ought to go by, and that it was just when the filter was beginning to be used there was the great danger. As long as there was no epidemic above London there was little or no danger; the danger came when an epidemic above London coincided with a broken-down filter. He would venture to say that when there was an epidemic of typhoid or cholera above London 16,000 bacteria in one c.c. was not safe. He quite agreed that the average London water supply was extremely good, and great pains had been taken of late years to improve it, but the pains taken were not sufficient; the filter beds were not examined frequently enough, they ought to be examined every day. Dr. Koch went so far as to say that whenever the number of bacteria exceeded 100—not because of the 100, but because it showed bad filtration—the water should not be supplied at all. If that were the case half the London water would have to run to waste, or more than half. It was a great mistake for Dr. Frankland to abuse the work of others. He (Dr. Dupré) had never consciously exaggerated anything; but, on the other hand, if he worked conscientiously he would be a coward not to state what the result was, however much it might conflict with the opinions or results of others. He stated distinctly, as he had stated before, that the danger to London was very small, but it was wrong to let London believe there was no danger at all. It might be small, measured by the number of lives, but who could say what was the value of any individual life. If they were willing to risk the danger, well and good; if not, they must spend so many millions; but it was distinctly wrong to say there was no danger at all. London ought to be clearly informed of the danger, and then let it face it if it liked.

Dr. CHILDS desired to ask a question with regard to the very important point relative to the number of bacteria in the filtered water as compared with those in the unfiltered. He was not aware that any qualitative comparison had been made, and he should be very grateful for any light on that point. For instance, in London filtered water there were certain micro-organisms very common, were those common also in the unfiltered water? Were there any qualitative results which went to corroborate the hypothesis that the bacteria found in the filtered water were derived, not from the unfiltered water, but from the sand of the filter or any other source? Any light on this point would, he thought, be of great importance. The most important revelation they owed to Dr. Frankland's genius was the fact that whatever the quantity of bacteria in the unfiltered water, if the filter were doing its work well, there was a reduction down to 100, 200, or 300 in the filtered water. He would also ask, in connection with the effect of cold on sand filters, whether the large increase in the number of bacteria was supposed to be due merely to mechanical interference with the surface of the filter, or had the ice any effect on the sand itself, and how far could such defect be prevented, if it were due merely to mechanical interference.

Dr. PERCY FRANKLAND, in reply, said it had long been known that the efficacy of the filtration process depended mainly on the surface layer of slime which was formed on the filter beds, and some German investigators were at first inclined to attribute the whole efficacy of the filter to it; but more recently the view which he had long advocated had been revived, that the depth of fine sand was also of importance. It had now been shown that the efficiency of a filter was dependent on two structures; first, the surface slime; and secondly, the depth of the fine sand. It was worthy of note that the efficiency of the filtration was occasionally impaired in the winter season, and the question arose what was the cause of that. It would appear probable that in the removal of the ice by the workmen, they might disturb the surface of the sand, and this having been pointed out, the necessary steps must be taken to prevent such disturbance. It happened also in severe winters, like that which occurred when Dr. Dupré and others investigated the London water supply, that the water in the sand itself became frozen, and thus the filter bed had to be thrown out of use, and as there was only a limited number of filter beds, the water had to be passed at a more rapid rate through the others, in order to furnish the necessary supply. The efficiency of filtration was greatly influenced by the rate at which the water passed, as he had shown many years ago. It was obvious, therefore, that both these causes might have a prejudicial effect. At some waterworks these difficulties had been fully recognised, and special precautions were taken, with the result that the diminution of inefficiency in winter was not noticed. He hoped that when the attention of English engineers was called to this danger they would take the necessary steps to guard against it. At the same time that some of the companies might be supplying imperfectly filtered water, others were supplying water as perfectly filtered as in the warmer weather, but there was no reason why, with due care and attention, uniformity in results should not be attained. With regard to the coincidence of the bad filtration with the sprinkling of typhoid over the metropolis, he did not feel competent to deal with that question. Mr. Shirley Murphy was not convinced of the connection himself; he felt it his duty to point out the coincidence, and everybody interested in the question would feel it his duty to watch carefully for any indications which pointed to the two facts being related as cause and effect, but at present there was no possibility of arriving at a definite conclusion. That any considerable amount of typhoid in the metropolis was produced by the water supply was obviously negatived by the Table they owed to Mr. Shirley Murphy, which showed that the death-rate from enteric fever in London was lower than the lowest of almost any town in the country. With regard to Dr. Dupré's remarks, he would point out that the only criticism he had offered on his paper was that instead of telling them what he himself thought of the London water supply, having a much greater experience in such matters than Dr. Koch—who though a recognised master of bacteriological methods was not an especial authority on water supply—he had handed over the task of condemning the London supply to Dr. Koch's standard of 100 per c.c. That was the only criticism he had offered on Dr. Stevenson and Dr. Dupé's report. But inasmuch as Dr. Dupré had brought the subject on the tapis again, he would point out the curious results of this delegation of the condemnation of the supply to Dr. Koch. They pointed out that the Kent water, which was not subjected to filtration at all, contained more than the standard number of bacteria. What inference was to be drawn? The standard of 100 referred to a filtration result, but the Kent water had nothing to do with such a result; was it to be condemned because it contained more than 100 colonies? That was the dilemma to which they were brought by adopting this standard. It had been entirely misapplied by Drs. Stevenson and Dupré. It was given by Koch merely as a guide to water engineers, showing them what sort of result they might expect from filtration. They were to take waters from the filter wells, cultivate them with a particularly specified gelatine, and examine the plates after 48 hours; but one of the points in these reports was that they obtained larger numbers because they submitted the plates to cultivation for five, six, and up to nine or ten days. That low standard had been taken up in this country as though it were inspired, and it was said that every water which contained more was bad, and every one which contained less was a good water. This was not applying the standard to the purpose for which it was designed at all, and was doing a gross injustice to Koch. The standards of purity were constituted by the waters themselves. People of practical experience knew there were certain pure water supplies, and nothing better could be obtained, and the standard was taken from such a supply. This standard was misapplied to the Kent water, which had nothing to do with filtration, and people were led to believe, by Dr. Klein especially, that it was thoroughly bad because it contained more than 100 bacteria per c.c. Dr. Dupré said he had produced only the best results, but that was not so, he had produced all the results obtained with London waters, and pointed out distinctly that on certain occasions the number of bacteria was excessive, and the connection between the excess and the cold weather was plainly indicated.

The CHAIRMAN then proposed a vote of thanks to Dr. Percy Frankland, which was carried unanimously, and the meeting adjourned.

Notes on Books.

SPECIMENS OF WORKING RECORDS AND ACCOUNT BOOKS FOR GOLD MINING COMPANIES. By Nicol Brown. Glasgow: Duncan Campbell & Son. 1896.

Mr. Nicol Brown has prepared and bound up together samples of all the books which he considers ought to be kept by gold mining companies. The task of providing a form of record which would suit all mines is a difficult, perhaps an impossible, one, considering the various characters of ores and the various treatments which they undergo; nor is it probable that many mining companies would find it necessary to keep all the twenty-six books, of which Mr. Brown provides specimens. But, at all events, it is open to them to make a selection of such as would serve their purpose, and the book is certainly one likely to be useful to secretaries of gold mining companies, who will find in it many suggestions, if they do not agree with all the details. The work is naturally open to criticism. Some authorities would consider it too voluminous, and many of the forms quite unnecessary; and certainly, for the usual companies, where only sixty to a hundred men are employed, this would certainly be true. A few criticisms may be offered. For instance, the first book suggested is a "Surface Prospecting Report Book." Now, in nearly every case this must be superfluous, as it naturally happens that the surface prospecting is done long before the property reaches the company stage. The second book is a "Diamond Drilling Report Book." In a very large proportion of mines this would not be required. For instance, the number of diamond drills in all Australia could probably be counted by very few figures, and it is believed that there is not such a drill in Western Australia at all. In the "Cyanide Report Book" no mention is made of silver, which always forms an important factor. Some of the books are merely ordinary account books, and for some—such as the "Order Forms for Stores"—an ordinary order book at a quarter the cost would answer the purpose just as well. But in a detailed work like this, opinions would vary according to the practice of the critic; and, as before mentioned, many of those who have to deal with the rather complicated forms of accounts required by mining companies, the boards of which are, in nearly every case, at a long distance from the seat of operations, will find it of practical value.

KNOWLEDGE: an Illustrated Magazine of Science, Literature, and Art. Vol. xix. Jan. to Dec., 1896.

The contents of the volume of *Knowledge* for the year 1896, are as varied as usual. There are several series of articles, the principal being on "Waves," by Vaughan Cornish; "Our Fur Producers," by R. Lydekker; "The Face of the Sky," by Herbert Sadler; and "Greek Vases," by H. B. Walters. The principal scientific discoveries of the year appear to receive sufficient treatment. The "Röntgen Rays" and "Helium" form the subject of special articles. Dr. Nevill contributes several articles on geographical subjects; Mr. W. Maunder, a number of astronomical articles; Mr. Paxton describes several variations of English trees; Mr. Pinches writes on archæology. The branches of science which appear to receive most attention, are astronomy and biology, but there are a great many interesting miscellaneous papers, all popular and simply written.

Correspondence.

KAFIRISTAN.

Dr. LEITNER has sent the following remarks, which he wrote down during the course of Sir George Robertson's lecture:—All honour to Sir George Robertson for his communication regarding that part of Kafiristan which has been mostly subjected to the degradation of Chitral proximity; but in order to judge of the entire question of Kafir manners, religion, languages, and racial origins, it is necessary to study those writers that, whether as enemies or friends, refer to them either in other parts not visited by Sir George, or in the same parts when in a state of greater purity and antiquity. Indeed, it is not too much to say now, what I prophesied in 1866, when I discovered the races and languages of Dardistan, of which Kafiristan is a part, that every year will add to the degeneracy and extend the destruction that owing to foreign influences—including our own—has overtaken the Fairyland of Asia and, speaking philologically, the cradle of human thought, as expressed in language. Therefore, if a man is not a trained linguist, a *sine quâ non* condition for such inquiries, he ought, at least, to study the existing material, which, if not ample, is sufficient, and at any rate the only basis for any real knowledge of the Kafirs. We have, first and foremost, the careful historian Arrian, and we not only find that Alexander the Great advanced against Nyssa, the heart of Greek Kafiristan, but that he discovered its inhabitants to be descendants of still older Greek arrivals under Dionysus. Of this, Colonel Holdich has given us a fragment of a Bacchic hymn, still sung by the initiated Kafirs of the Bashgal valley [*see* the "Journal of the Royal Geographical Society"]. Passing over Megasthenes and other classical writers, whom it is absolutely necessary to study, we come to the Mahommedan period, and there we find Mahmud of Ghazni chasing the Buddhists into Swat, Bajaur, and Kafiristan. The very first sculpture which I excavated at Tahkt-i-bahi, near Mardan, as Sir George has it, was a seated king, in Kafir, or if one prefer, in European fashion; this was one of the minor reasons which induced me to call these sculptures "Græco-Buddhistic," a name that, after much controversy, has been accepted as correctly designating a period in art, history, and religion. Passing over Arabsha's "Timur," we have Abulfazl giving us a most detailed account of the campaign of Timur in 800 A.H., or 1298 A.D., against Kafiristan, including the setting up of a memorial stone, which has recently been found by the troops of the Amir of Afghanistan, and to which he has added one on his own exploits. We have then a short account of the Kafirs by the Emperor Baber himself, who allowed himself to be propitiated by them with a present of wine in leather-skins, though he confesses that he disliked its taste. He refers to them as a race that even Alexander and Timur could not subdue, but he spared them and, I believe, drank to them in a song that is in my possession. Among Europeans we must not forget Elphinstone, Masson, and in recent times, Biddulph, whose "Tribes of the Himdukush," in spite of its acunæ, is a mine of information and suggestion. From Macnaer and Lockhart's party we can also profit, and I have numerous Persian and other manuscripts, as also reports dictated by my Kafir and other retainers, on the translation of which I am engaged. Finally, we all watch with interest the decipherment of an nscription found in Swat, in an apparently Greek rchaic character, with which Mr. Senart is now ccupied. I, for one, shall look forward to Sir G. Robertson's Bashgali vocabulary in the hope of its dding to my own collection regarding the Kafir ialects which, with every deference to the speaker, e all ancient Aryan Prakrits, and connected with ne another, as I have no doubt is also the case with he Presun dialect, "which no fellow," in Sir G. obertson's party, "could understand." As regards politics, which the reader of the paper professes to avoid, but on which he has thrown many side-lights, all I can say is that it is a serious mistake to call Christians "Kitabi Kafirs," and the non-possessors of a sacred book "bi-Kitábi" Kafirs. Such a view would, from a religious standpoint, justify the Amir in waging war on the British as he has on their "brethren," the Kafirs. In my report on "The History of Indigenous Education," to the Education Commission of the Government of India, I have pointed out the danger of settling any religious Muhammadan question by Persian terminology. It is Arabic, and Arabic alone, that is authoritative in such matters, and there we find that Christians and Jews are called "Ahl Kitab," or "possessors of a sacred book," not the Bible, "for instance," as Sir George Robertson says, but *only* the Bible, or, more in detail, the Tora or ancient Testament, the Injil or new Testament, and the Zabur or Psalms. Against them any Jihád or holy war is unlawful, except under the provocation that Mahommedans under them are turned out from their homes *because* they are Mahommedans. This, and only this, is the right view and one that our political officers should not ignore in the interest of the peace of India, though if this view were not the right one I would be the last person to urge it, no matter what the political consideration. I hope, however, that the Amir will, with his enlightened mind, consider a treatise on Jihád, embodying the orthodox view, that I intend to send him as an old, but impartial friend. As for the Kafirs preferring death to Mahommedanism, this has been attested on numerous occasions in history and more recently in Badakhshan in 1866, as also during the last Afghan campaign, when the Amir told Miss Hamilton of 500 Kafirs having burnt themselves to death rather than embrace Islam. At the same time, however, even in the days of Timur, Mahommedan scholars or Maulvis travelling in Kafiristan were invariably safe. The character of the Kafirs is emphatically pagan of the classical type, and more resembles that of Europeans than that of any other Asiatic race. Their fondness for discussing everything in local Parliaments, their deference to public opinion, their love of fun and drink, their pluck and greed, their quarrelling and making up, not to speak of their easy faith, all show a race that, with all its faults, we may rightly love as "brethren of the Europeans." My measurements and anthropological photographs also show that since 1866 and 1872, when they were taken, they were far nearer to, if not sometimes identical with, the classical type than in the interesting snap-shots that have so ably been re-drawn by Mr. McCormick and exhibited this afternoon. At any rate, the members of the Bengal Asiatic Society, and of the Punjab Government of 1866 here to-day, who then so aided the Dard and Kafir researches, as also you of the Society of Arts who have seen and heard Jamshêd, the Siah Posh Kafir, whom I introduced here in 1877, may still have a sympathy for a race in whose fate so many of the *savants* and learned bodies of Europe interested themselves, and that is still worthy of kind consideration in spite of political reasons that might seek to minimise its virtues and justify its destruction.

G. W. LEITNER.

Oriental University Institute,
Woking, May 6th, 1897.

RAILWAYS TO INDIA.

In the discussion on Mr. Black's paper we all seem to have lost sight of the double transhipment of passengers and goods at Alexandria and Basra. This would, of course, cause much inconvenience and some delay. In my journeys backwards and forwards to India, I have personally preferred to take different continental routes in order to see the countries and people; but from inquiry it would seem that the majority of passengers prefer to get into the steamer at the docks in London and be taken direct to Bombay, Madras, or Calcutta. I noticed some retired Indian officials at the meeting, and it seems a pity they did not give us the benefit of their opinion.

J. W. PARRY.

The Jungle, Anerley.
May 8, 1897.

General Notes.

ST. PETERSBURG EXHIBITION OF POSTERS.—Information has been received from the Foreign-office, through the Science and Art Department, respecting an International Exhibition of Artistic and Coloured Advertisements, to be held next November, at St. Petersburg, by the Imperial Society for the Encouragement of Art, under the patronage of Her Imperial Highness the Princess Eugénie d'Oldenbourg. The Princess has written to the British Ambassador, at St. Petersburg, requesting him to make the Exhibition known in England.

ITALIAN WINE PRODUCTION IN 1896.—The Italian *Gazzetta Ufficiale* has recently published a report by the Minister of Agriculture on the wine harvest of 1896, comparing the results with those of the preceding year. The total yield was 21,373,092 hectolitres (hectolitre = 22 gallons), as compared with 24,245,836 hectolitres in 1895—a falling off of nearly 3,000,000 hectolitres. Although the quantity has decreased, the quality of the Italian wine appears to have greatly improved, thanks to the favourable climatic conditions and the diminution in vine diseases. The largest quantity of wine was produced in the Southern Adriatic provinces, 3,575,417 hectolitres in 1896, as compared with 2,472,412 in 1895. Sicily comes next with 3,558,749 hectolitres, as against 4,257,783 in the preceding year. Then follow the Southern Mediterranean provinces with 2,559,131 hectolitres, Tuscany with 2,741,745, and Emilia with 2,039,583. Piedmont produced 1,929,697 hectolitres, Lombardy, 1,032,722; Venice, 952,306; The Marches, 1,878,206, and Sardinia, 366,780 hectolitres.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

MAY 26.—"Silver and Prices: the Economic drain of Debtor Nations." By MORETON FREWEN, B.A.

CANTOR LECTURES.

Monday, May 24, at Eight p.m.:—
LEWIS FOREMAN DAY, "Design in Lettering."
Lecture IV.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 24...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Lewis Foreman Day, "Design in Lettering." (Lecture IV.)

TUESDAY, MAY 25...Royal Institution, Albemarle-street, W. 3 p.m. Dr. Ernest H. Starling, "The Heart and its Work." (Lecture I.)

Medical and Chirurgical, 20, Hanover-square, W. 8½ p.m.

Statistical, in the Theatre of the United Servic Institution, Whitehall, S.W., 5½ p.m. Si Robert Hunter, "The Movements for the Inclosure and Preservation of Open Lands."

Photographic, 12, Hanover-square, W., 8 p.m. 1 Mr. Chapman, "The Optical Effects of Intensification." 2. Mr. H. T. Malby, "Som Notes on the Correct Rendering of the Colours o Flowers."

Anthropological, 3, Hanover-square, W., 8½ p.m.

United Service Institution, Whitehall, S.W., 3½ p.m Major A. F. Gatlitt, "A Royal Marine Reserve."

WEDNESDAY, MAY 26...SOCIETY OF ARTS, John-street Adelphi, W.C., 8 p.m. Mr. Moreton Frewen "Silver and Prices: the Economic Drain o Debtor Nations."

Geological, Burlington-house, W., 8 p.m.

Royal Society of Literature, 20, Hanover-square, W 1 p.m.

THURSDAY, MAY 27...Society for the Encouragement of Fin Arts, 9, Conduit-street, W., 8 p.m. Mr. E. I Webb, "Our Rude Forefathers (continued)-Saxon and Norman."

Royal Institution, Albemarle-street, W., 3 p.m. M Churton Collins, "Burke and the Revolution." (Lecture II.)

FRIDAY, MAY 28...United Service Inst., Whitehall-yar S.W., 3 p.m. Captain F. N. Maude, "Th Training of Men with the Colours in Relation t their Subsequent Employment in Civil Life."

Royal Institution, Albemarle-street, W., 8 p.m Weekly Meeting. 9 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m.

SATURDAY, MAY 29...Royal Institution, Albemarle-stree W., 3 p.m. Mr. J. A. Fuller Maitland, "Mus in England during the Reign of Queen Victoria. (Lecture I.)

Journal of the Society of Arts.

No. 2,323. Vol. XLV.

FRIDAY, MAY 28, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Mr. Lewis F. Day delivered the fourth and last lecture of his course on "Design in Lettering," on Monday evening, 24th inst. On the motion of the Chairman a vote of thanks was passed to the Lecturer.

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday May 20; Sir H. Mortimer Durand, K.C.S.I., K.C.I.E., in the chair.

The paper read was, "Kerman and Persian Beluchistan: with special reference to the Journeys of Alexander the Great, and Marco Polo," by Captain P. Molesworth Sykes.

The paper and report of the discussion will be printed in a future number of the *Journal.*

CONVERSAZIONE.

The Society's *Conversazione* will be held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 16th June.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. In addition to this, each Member will be able to purchase additional tickets, the price of which will be 5s. each up to the day of the *Conversazione*; on that day the price will be raised to 7s. 6d. It is requested that Members requiring these additional tickets will make early application for them. Every application must be accompanied by a remittance.

Further particulars as to the musical and other arrangements will be published in the *Journal* later on.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The fourth meeting of the Congrès International de l'Enseignement Technique will be held this year in London, commencing on the 15th of June next. The previous meetings of the Congress were—in 1886 at Bordeaux, in 1889 at Paris, and in 1895 at Bordeaux. The meetings will be held at the invitation of the Society of Arts, and of the Worshipful Companies of Mercers, Drapers, Fishmongers, Goldsmiths, Merchant Taylors, Vintners, Clothworkers, Leathersellers, and Carpenters.

The Congress will be opened at 11 o'clock, on the 15th of June, by an address from the President, the Duke of Devonshire, K.G., and from the President of the last Congress, M. le Professeur Léo Saignat. The meetings will be held on Tuesday, Wednesday, Thursday, and Friday, from 11 to 1, and from 2.30 to 5.

Mons. Felix Martel, Inspector-General of Public Instruction, has been appointed delegate by the French Government, and Mons. Eugène Rombaut, Inspector-General of Industrial and Professional Education, by the Belgian Government.

The subscription to the Congress, for others than delegates of foreign Governments, members of the Society of Arts, or liverymen of the companies subscribing, will be five shillings. This will entitle them to a copy of the report of the proceedings.

Applications for persons desiring to become members of the Congress can now be received, and should be accompanied by the amount of the subscription. In return for this a ticket will be sent entitling the members to all the privileges of the Congress.

Members of the Society of Arts and liverymen of the companies will be admitted to the meetings of the Congress on signing their names at the door.

The subjects for discussion at the Congress will include :—

Industrial Education :—

1. Advanced Instruction. Polytechnics, Universities, Colleges.
2. Secondary Instruction. Higher Technical Schools; Secondary and Intermediate Schools; Evening Schools

Commercial Education :—

1. Advanced Instruction. Colleges; High Schools and Institutes of Commerce.
2. Secondary Instruction. Commercial Schools; High Schools; Classes for Adults.

The meetings will be held in the Rooms of the Society of Arts. Should it be found desirable to arrange for sectional meetings, accommodation will be provided in the neighbourhood.

The papers will be printed and distributed at the meetings. The reader of each paper will be allowed twenty minutes to state the substance of the paper. Other speakers will be restricted to ten minutes.

The proceedings of the Congress will be reported in English. Papers intended for the Congress may be in French, German, or English, and speakers may make use of any of these languages.

All communications relating to the business of the Congress should be addressed to the Secretary, Society of Arts, John-street, Adelphi, London, W.C.

The Right Hon. the Lord Mayor of London has kindly expressed his intention of inviting members of the Congress to an evening reception at the Mansion-house, on the 17th of June. The Society of Arts annual *Conversazione* will be held on Wednesday, the 16th of June, and members of the Congress will receive an invitation to it. On Saturday, the 19th of June, it is proposed to organise an excursion, for foreign delegates.

Arrangements are being made to afford delegates and members an opportunity of visiting the polytechnics and other educational institutions of London.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, May 4, 1897; Major G. E. W. MALET in the chair.

The paper read was—

ARCTIC AND ANTARCTIC.

By AUBYN TREVOR-BATTYE,

B.A., F.L.S., F.R.G.S., &c.

I am going to try and take this afternoon a comparative view of the regions which form the two ends of the world. It will not be possible, in our limited time, to trace the story of the various expeditions to which we owe such knowledge of these as we possess. Perhaps in the case of the Arctic regions, this is hardly necessary; recent exploration has turned popular attention so closely upon the North Polar area, that there are few who do not now know, at all events in outline, the leading facts in discovery there.

But it is different with the Antarctic area. So little, comparatively, has been done there, and so long a time has elapsed since that little was done, that a short review of South Polar exploration will not be out of place. But the points I more especially want to put before you in a general way are the following:—The resemblances or differences between the two areas as at present known; the character of the ice in the two regions, the character of the land, the character of the sea; the distribution of the larger forms of animal life, the facts of existing forms of vegetable life, and something of that which we know of its past. In short, my hope is to leave with you a mental picture, in which the northern and southern ends of our planet shall be clear from one another, and fill a distinct place.

A glance at the two maps I have thrown on the screen will show that the two areas differ in this—that while the land masses in the north are separable into important groups of islands—Spitsbergen, Novaya Zemblya, Franz Josef Land, and others, the land area in the south is (if we except a few groups of small islands, *e.g.*, the South Shetlands) probably concentrated into a continent which includes the geographical and magnetic Poles.

Now, we will take the sea area of the Arctic region first.

In the greater part the sea, where it is open, is navigable by frail and small boats, for it but seldom rises into formidable billows; and in the neighbourhood of the pack ice is commonly calm almost as a mill-pond; and this is true of the pack itself. Inside the pack the danger is not from ice carried tumultuously about on a heavy sea, but from the steady, sustained pressure of a vast body as a whole, resulting in what Dr. Nansen has called "pressure ridges." The Arctic ice is of various kinds: jagged, angular, crystalline-looking bergs, which are the ends of glaciers fallen into the sea as "seracs," or broken upwards by the pressure of the waves; flat floe-ice, formed on the sea itself; river ice which has come (mud-laden often) from the great Siberian or other rivers, and ice of other kinds.

Over a large continent as Greenland, inducing a great sustained precipitation of frozen vapour, the snow, welded by countless generations of partial melting, lies as an ice-cap many hundred feet thick, showing at intervals only the highest peaks of submerged mountains which rise as "nunataks"—to use the now-accepted Eskimo word. But elsewhere, as in Spitsbergen, the ice-cap is but of limited extent, giving place to mountain ridges with glaciers which fall to the sea, or to valleys, green in summer, and holding streams up which may run *Salmo alpinus*, the northern salmon or charr.

Except here and there, as for instance in Jan Mayen, where a high volcanic mountain rises, the great preponderance of the land is of tertiary or secondary formation, containing the remains of an ancient fauna and flora. Arctic geology tells us clearly of a warm period when the spruce, the magnolia, the deciduous cypress and palms flourished there, and the sea supported its coral colonies as warm southern seas do now. The theory until lately held of a shallow Polar basin, containing an archipelago of islands in which the geographical North Pole was set, must now be given up, for Nansen's soundings have shown a sea of 2,000 fathoms in depth at about 80° N. Lat., which is probably continuous with the Atlantic itself.

Under the Arctic conditions of the present day the forests have disappeared, or have been reduced to two or three species of tree at the most. These—the creeping birch (*Betula nana*), the woolly willow (*Salik lanata*), with the polar and veined-leaf willows (*S. polaris* and *S. reticulata*)—if we may dignify them with the name of trees, are seldom more than two inches high. But, in addition to these, the list both of flowering and of cryptogamous Arctic plants is a very long one. In Spitsbergen are found two ferns, one of which (*Crysopteris*) I myself brought back last year, while the horsetails and marestails (*hippuris* and *equisetum*) flourish in damp places, and mosses and lichens abound. The flowering plants, though dwarfed in habits, are as gorgeous in colour as here with us at home. Not only saxifrages and drabas—the characteristic plants of the Arctic regions—but buttercups, cuckoo-pint, and many *compositæ*, rosaceous plants and others, lend to the green river valleys masses of purple and gold. Although the list of species lessens rapidly towards the more extreme North, even higher than 83° N. Lat., flowering plants and grasses grow. Even upon the isolated nunataks, solitary in the Greenland ice-sheet, flowers have been found. If we regard these, as perhaps we may, as survivals from a warmer and more favoured epoch, one may well wonder at the principle of vitality which has preserved them to the present day. We know, of course, that there is no reason why seeds should not remain even under the ice of ages in a state of suspended growth. But there are grounds (which do not seem to me too wild for consideration) for supposing that even some of these plants themselves have been buried under the ice-cap to flourish again when restored by its removal to the light and air. It is certainly true, as my own personal observations have shown, that no sooner is the ice of a dying glacier removed than the ground lately covered by it is occupied, as if by magic, with growing plants. Although the perpetual daylight of half the year favours an astonishingly rapid growth of plant life (so that in the Arctic summer ground this week snow-covered is the next week ablaze with flowers) it is not favourable to ripening of seed. Hence the proportion of Arctic *annuals* is small, and the proportion of plants that increase from the root large.

Not only are the Arctic seas teeming with invertebrate life, not only do they support many forms of seals (as the bladder-nose, the harp seal, and the blue seal), the walrus, and several cetaceans (the Right whale, the bottle-nose, the rorquals, the narwhal, and the white whale, or Beluga as examples), but terrestrial mammalia, though limited in number are, in general, well-marked. The Polar bear, the fox and the ermine represent the carnivors, the musk ox and reindeer the ruminants, and the Arctic hare, the rodents.

This Arctic hare, blue in summer and turning white in winter, is precisely the same as the hare we find on our Scotch and Irish hills. If then we grant, as we may, a tertiary land-causeway, which connected Greenland with North Europe, including Iceland and the Faroes, we have at once a theory of how this hare may have come to us, and have been isolated when its retreat was cut off by the subsidence of the land. I use the words "may have come to us" deliberately, for I believe we may go further, and not unreasonably conjecture that the animals I have mentioned had their origin and birthplace in the Polar area. But unfortunately time does not admit of our going more closely into this most interesting question.

The bird-life of the Arctic area is very varied and strangely familiar to a British ornithologist. For there the birds, who leave us on the approach of summer, go to nest, some of them travelling indeed all the way from Africa into the Polar lands. Our wild swan, our wild geese, many of our wild ducks, our grey plover, a large proportion of our wading birds and of our gulls, and more birds than I can mention here, leave us then and fly up to nest in these lands of snow and ice. So rapidly do they travel that knots and curlew sandpipers, who have not left us till the end of May are back with their young ones on our mud-flats before July is out.

And the Arctic regions are not devoid of human life. High up, in Spitsbergen, in Franz Josef Land, in Greenland, north of 75° no man lives. Yet within the Arctic circle, round what I may call the Arctic littoral, many tribes dwell; here are found Eskimo, Samoyeds, Ostiaks, Tchuckchis, all probably traceable to one primitive stock, Asiatic, and popularly speaking, Mongoloid. Of these, the Eskimo will be best known to you, and there are traces of their presence even as far north as Lancaster Sound. The Samoyeds, with whom I myself lived for some time, are in certain respects the most interesting of the races. They are true nomads, nomads by necessity, because they are dependent on their reindeer, who wander from pasture to pasture in search of fresh lichens and moss on which they feed. The religion of these people is a form of Shamanism. They put their faith in their great god Nûm, whose image, carved in wood, and called "Shyadey," is to be seen on prominent eminences devoted to him. Some of these holy hills are occupied by many of these figures, and round them lie the bones of sacrificed reindeer. Little images of Nûm are also worn as fetishes underneath the clothes. Owing to contact with the Russian traders and to the degrading attraction of the vile Russian spirit known as "wodka," these poor people are no doubt deteriorating fast, but in isolated places, such as Kolguev Island, where I lived with them, they retain their primitive customs and better qualities unspoilt. But, as I shall have much to say of them when we come to the lantern slides, we will leave them for the present.

This, then, is the North Polar area: ice-laden calm seas; glacier, or ice cap, but green valleys in summer with flowers ablaze; the rocks telling their story of ancient forest-life; musk ox, reindeer and other land mammals thriving on the land; nomadic races peopling its lower latitudes down to the Arctic circle—the Arctic circle itself cutting (in Scandinavia) through a land where civilised man lives in towns, where the church rears its steeple, and trade goes on normally as in a country market-town at home.

Now turn to the Antartic. The first voyag of any importance since the days of Captai Cook in 1772 is that of James Weddell Master in the Royal Navy in 1823, wh penetrated to 74° 15′ S. but *saw no land* He says himself that he could have penetrated farther but for the fact that he ha 1,000 miles of sea, strewn with ice, to travers ere his return. He discovered and named th Shetland Islands.

Next, Sir James Clark Ross in 1841 an 1842 reached the 78th parallel and discovere Victoria Land. No other explorers than thes have ever passed the 70th parallel S. Lat.

D'Urville discovered Adèlie Land; Biscoe servant of the merchants Enderby, discovere Enderby Land. The discovery of Wilkes Land by the U.S. Expedition was spoiled b certain inaccuracies of its commander, bu this does not detract from the plucky natur of the enterprise.

By far the most important of the voyage I have mentioned was that of Sir James Clar Ross. It was then for the first time that an serious and continuous effort was made t ascertain by dredging oceanic deep-sea life He took his ships (which had been carefull strengthened in Chatham Dockyard) with th greatest intrepidity into the pack ice, where o his third attempt he was so beset that he la at its mercy for weeks.

Everywhere Ross's soundings and the island on which he landed showed formation of volcani nature, which culminated in his discovery o Mounts Erebus and Terror, 12,000 and 15,00 feet high, the former at the time of Ross' visit in active eruption. Under these mountains, was McMurdo Bay (as Ross terme it), and here (though he could not himself o that occasion get nearer than 12 miles of th land because of the pack), the next Sout Polar Expedition will probably lay its ships.

From this bay ran a great cliff of ice 15 to 200 feet in height, eastward for severa hundred miles. McMurdo Bay is the on possible harbour that has yet been recorded o the Antarctic continent, if continent it is. Fo the rest this region shows a chain of mountain from which the continent drops away toward Graham's Land covered with an ice-cap a Greenland is. To the south-west of Georgia near Weddell's Longitude, Ross found a dept of over 4,000 fathoms; while at various point in the surrounding ocean, between Lat. 30 an 50, there is an ascertained depth of two miles These and other considerations, which I hav not time to discuss, point to sea environing central land-mass, of which the few spots at present sighted lie on the boundary.

The sea, unlike the great Arctic Ocean, is tumultuous and subjected to severe and prolonged gales, and Ross tells that when his ship rose on the crest of a wave their consort's topmast was only just to be seen. The swell thus induced extends even into the ice-laden sea, and the risks to sailing ships consequently are great.

Birds excepted, no land animal has ever been discovered inside the Antarctic circle, and no vegetation of any kind, not even a lichen, has been, I believe, discovered south of 65°. On the other hand, the seas are, as the Arctic Seas, swarming with invertebrate and unicellular vegetable life.

The bird-life of the Arctic—that bird-life, which, as I have said before, includes so many of our British birds—gives place to unfamilar forms, to the large petrels and in the extreme south to penguins. These strange-looking birds—their wings useless for flight and modified as swimming organs—so that in the water they resemble a shoal of porpoises, nest in immense congregations. These penguin "rookeries," with their lanes and avenues among the breeding birds, form labyrinths through which a man can with difficulty find his way. Cetaceans and seals are there in numbers, but different from those of the high north. Needless to say, in place of those tribes we have referred to of the Arctic littoral, no human beings are known to exist.

The icebergs of the Antarctic are very characteristic, often of immense size—floating ice islands of miles in extent; they are "chunks" broken off the great barrier, or off of a glacier's projected front, and are flat and tabular in appearance.

One or two short visits have of late years been paid to high southern latitudes, notably that of the Norwegian sailing-boat *Jason* under Captain Larsen, of Tranö, in 1893, who brought from Seymour Island some tertiary fossils and bits of fossilised coniferous wood.

Science wants to know more about the Antarctic, especially in view of magnetic variation in the interest of navigation—it wants a complete series of observations taken in *wooden ships*. But on all these points, I cannot do better than quote our great oceanographer, Dr. John Murray:—

"To determine the nature and extent of the Antarctic continent; to penetrate into the interior to ascertain the depth and nature of the ice-cap; to observe the character of the underlying rocks and their fossils; to take magnetic and meteorological observations both at sea and on land; to observe the temperature of the ocean at all depths and seasons of the year; to take pendulum observations on land, and possibly also to make gravity observations at great depths in the ocean; to bore through the deposits on the floor of the ocean at certain points in order to ascertain the condition of the deeper layers; to sound, trawl and dredge, and study the character and distribution of marine organisms—all this should be the work of a modern Antarctic expedition.

"For the more definite determination of the distribution of land and water on our planet; for the solution of many problems concerning the Ice Age; for the better determination of the internal constitution and superficial form of the Earth; for a more complete knowledge of the laws which govern the motions of the atmosphere and hydrosphere; for more trustworthy indications as to the origin of terrestrial and marine plants and animals, all these observations are earnestly demanded by the science of our day." *

Let us remember that the perils and difficulties from navigation experienced will now be minimised by the use of steam.

In conclusion, I leave you with the hope that this country may yet send out a new Antarctic expedition. I am aware that in the short time at my disposal I have only been able to put this subject before you in a very sketchy and I fear not very interesting way, but believe me, that is not the fault of the subject, or only because it is so big; if I have succeeded in giving my audience any clearer idea than perhaps they had before, of the opposite points of our planet, I shall be pleased and content.

DISCUSSION.

The CHAIRMAN said he should like to ask Mr. Trevor-Battye what was the age of the lilliputian trees he had described, two inches high; were they annuals?

Mr. TREVOR-BATTYE said they certainly were not annuals. He had not tested them himself, but an account had been given from which it appeared by the number of rings that the age of some of these trees was fifty years. He had, however, conveyed a wrong impression by speaking of them as trees; they were little shrubs, and the woody portion was not nearly so large as a cedar pencil.

The CHAIRMAN, in proposing a cordial vote of thanks to the reader of the paper, said he felt a great interest in the subject. He could only trust that the hopes which had been expressed as to an antarctic expedition would be fulfilled before many years had passed. It seemed rather a scandal to England with her great powers of exploration, and numbers of determined voyagers who were desirous of adding still further to the knowledge we already possessed of those regions, that more attention had not been paid to those interesting regions in the southern hemisphere.

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* The "Geographical Journal," Vol. III., p. 24.

The vote of thanks having been carried unanimously,

Mr. TREVOR-BATTYE, in reply, said there was some ground for hoping that an expedition might be sent to the antarctic regions next year. The Admiralty had been approached more than once on the subject; but though they always received the idea kindly, and expressed great sympathy with it, they said, not unreasonably, that they were not in a position to spare either money or ships for an antarctic expedition. Mr. Goschen had expressed the hope that the matter might be taken up by private patriotism, when it would have the countenance of the Government, so that any expedition which went out might be of a national character. It would be strange if amongst the large and increasing number of merchant princes in this country means could not be found. Such an expedition would cost at a minimum about £50,000, and it would be hard if they could not find five men who would guarantee £10,000 each. It had been done before, for Sir Felix Booth owed his baronetcy to such an enterprise, and Enderby Land its name and discovery to a merchant. He hoped some one would come forward in this jubilee year especially seeing that Queen Victoria's land was discovered by Sir James Clark Ross in the opening year of the reign, and if an expedition could be initiated which would complete that discovery, it would certainly add much to the lustre of the reign they were now celebrating.

TWENTY-SECOND ORDINARY MEETING.

Wednesday, May 26; WILLIAM HENRY GRENFELL, B.A., in the chair.

The following candidates were proposed for election as members of the Society:—

Brown, William Peter, 3, Austin-friars, E.C.
Cross, Charles Frederick, 4, New-court, Lincoln's-inn-fields, W.C.
Ewens, George Thomas, West-hall, Kew.
Flood, Alfred Edward, Rowborough, Cookham, Berks.
Mitchell, James F. B., Clerk-road, Jacob-circle, Bombay, India.
Settna, Maneckjee Framjee Harmusjee, Marknes-buildings, Fort, Bombay, India.

The following candidates were balloted for and duly elected members of the Society:—

Barker, Gerald, 1, Victoria-street, S.W.
Chrimes, Charles Edward, Selwood, Rotherham.
Dyson, Robert, Fairfield, Rotherham.
Powell, Harry J., 26, Tudor-street, Whitefriars, E.C.
Rodda, Edward Duncoff, 6, Gold-street, Roath, Cardiff.
Zeal, Hon. Sir William Austin, K.C.M.G., M.L.C., Melbourne, Victoria.

The CHAIRMAN in introducing Mr. Frewen, apologised for the unavoidable absence of Sir William Houldsworth, and referred to the recent great contest in the United States when the two great parties seemed to be divided on the currency question and almost on that alone. Since then, the successful party, which was supposed to have saved the country by upholding the gold standard, had sent a delegation to Europe with the object of obtaining a settlement, on international lines, of the currency question which divided the world. It seemed very difficult to raise public interest in this question in England, but it was of the highest importance that people should discuss it and arrive at an unbiassed decision.

The paper read was—

SILVER AND PRICES: THE ECONOMIC DRAIN FROM DEBTOR NATIONS.

BY MORETON FREWEN.

The problem, what is to be the future exchange value of the money which three-fourths of the human race tender for their goods, is in itself a problem of immense importance. But, stated thus simply, it might appear to be chiefly a question of international book-keeping. When, however, we have come to recognise that, with every reduction in the price of silver bullion, the exchange with Asia fall; that when the silver currencies of Asia depreciate all the export trades of Asia are stimulated; then, indeed, we have arrived at the threshold of what is evidently a great race question—a question of how the white man with the yellow money is to meet the competition of the yellow man with the white money.

The Silver Question then, even from this standpoint, is clearly of infinite interest; but, by the light of the recent elections in the United States, we see that even more than a race conflict, there is involved the most bitter class antagonisms; and just as these antagonisms and the knowledge of all they portend have only after twenty years really worked their way to the political surface in America, so also, beyond all doubt, they are destined to emerge not much later within the British Empire and in Europe, and with revolutionary violence unless our statesmen are able to secure an equitable settlement before any long delay.

THE UNEARNED INCREMENT IN GOLD.

From all sides the evidence accumulates that too great a subscription to revenue is to-day being made by the very poor, too small a subscription by the very rich; therefore, men's minds have begun to recognise the true resources of taxation in what is called the "unearned increment" wherever that increment is to be found. Now, since 1873 the value of the gold sovereign—its purchasing power—has nearly doubled; the man then who owned £100,000 in 1873, and who to-day owns £100,000, is nearly twice as wealthy now as he was in 1873. Rightly or wrongly—I do not wish to prejudge the issue—our economists declare that this rise in the value of the sovereign results from changes in monetary legislation—changes in Germany, France, and America in 1873 and in England in 1893—changes which for the first time in history have given a monopoly value to gold. If, then, an unearned increment, which has nearly doubled the wealth of certain classes, has been obtained by design and not by accident—the recent attempt in America to prevent the further enrichment of the money owners, can hardly be attacked on moral grounds. A quarter of a century ago the late Mr. John Bright, at a time when the mere accident of the great gold discoveries in California and Australia had added some 50 per cent. to the selling value of English land, was in favour of taking this "unearned increment" by means of taxing the landlord. But if that vast unearned increment, which has now so enriched the fundlord, has resulted from no bounty of nature, as was then the case, but from alterations in monetary laws since 1873, here is clearly an unearned increment which should, on every moral ground, be attracting the attention of our Treasury officials.

BRITISH INDIA'S ABSORPTION OF SILVER.

In addressing your learned Society to-night, I have no desire to enlarge upon that somewhat dreary topic, "Bimetallism" so called. If a bimetallist is one who believes that the enduring settlement of the silver question involves the invention by Great Britain of a new and legal tender, silver coin, then I am not a bimetallist, for I believe no such change is necessary. The world had effective bimetallism until 1873, and to that beneficent monetary system which obtained before 1873, England and not France was the largest contributor. For by keeping the mints of 250,000,000 of our people in India open to the unlimited coinage of silver, and by rigidly demonetising gold in India, England greatly reduced the demand for gold—which demand would otherwise have resulted in sweeping most of the new gold of Australia and California into the hoarding places of the Orient*. I believe that what England did for silver before 1893, is at last beginning to be recognised, in view of that awful collapse in the silver exchanges, occasioned by England's anti-silver legislation in 1893. And when in France and Germany public opinion recognises the impolicy of waiting, until England does more for silver, than take, as she has often taken, in her Indian Empire, the entire silver produced by all the mines of the world during the year — when France and Germany have learned this lesson, as I believe America has learned it already, then indeed we shall witness the close of this barbarous period, of exchange disasters, and of wrecked agriculture, with which experimental legislation has afflicted us for now a quarter of a century.†

To the efforts of the American Monetary Commission, now in Paris, I offer this small contribution. Let them point out to the French authorities from the Report of our Silver Commission in 1875, that during the twenty-five preceding years, while the product of all the silver mines in the world was valued at £220,000,000 sterling, England's Eastern Empire absorbed of this sum no less than £164,000,000.

But it is far from my desire this evening to theorise as to the best method of securing for the world steady exchanges. That subject is endless. It is enough to point out that between the two parties—the party which believes that universal free coinage of both metals is required to maintain parity, and the other party which believes that a single great nation with open mints can act as money changer for the world—between these two parties, a third party is now emerging which believes that one or at most two great nations, with open mints, can in conjunction with silver monometallism in India, settle our present exchange troubles, and for all time to come maintain the ratio.

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* Between 1848 and 1877, the aggregate trade balances in favour of India amounted to £511,000,000, a sum largely in excess of all the gold which came during those years, both from California and Australia. Confronted with such figures, what ground is there for the belief that, given free coinage in Europe or the United States, any considerable amount of new silver will ever remain in the currencies of Europe or America?

† Between 1856 and 1860 India's net importation of silver was £51,500,000; the total silver production from the world's mines was £40,700,000.

THE FALL OF PRICES AND THE ECONOMIC DRAIN FROM EGYPT AND THE UNITED STATES.

I now come to that portion of my subject, where we are no longer in the domain of theory, but where we are able to deal with accepted facts and figures. It is quite evident that as prices fall, there must result an increasing economic drain from debtor nations; I mean either from those nations, whose national debts are largely held abroad, or from those nations which, for industrial developments, have been large borrowers from other countries. Egypt may be said to afford an extreme instance of the former class of debtor nations, and the United States of the latter class. Let me put it in this way—the National Debt of Egypt is, roughly, £100,000,000 sterling. Egypt is a purely agricultural community, with a little over 5,000,000 acres of cultivable land all told. The whole debt of Egypt is owned abroad, therefore, practically, a foreign mortgagee has a mortgage of £20 per acre upon the entire Nile valley. His interest is paid to the mortgagee by the export of produce, chiefly of cotton. Now, cotton having fallen in value more than one half since Khedive Ismail forced his country into this morass of debt, it follows that twice as much of the produce of each acre has to be exported from Egypt. Such is the added burden of lower prices in the ancient land of the Pharoahs. Now let us take the case of the New World. The United States has borrowed enormous sums of money, in Europe, to build railways, to build towns, to clear farms, to build breweries, to develope mines. Estimates differ greatly as to the amount owed by America abroad, but it is probably safe to reckon it at £600,000,000 sterling. I may remark here, that as the known external indebtedness of only 4,000,000 people in Australasia is over £350,000,000, it might be safe to estimate the external debt of the 70,000,000 people in the United States at a higher figure. Let us say then, that the interest annually paid by the United States in Europe is £30,000,000; that to send her produce to Europe, there to exchange it for the money she owes Europe, requires a payment of some £15,000,000, in freights, to our shipowners; and further, that American visitors spend annually at least £15,000,000 in Europe. From these figures it is evident that the economic drain from America, a drain represented by the excess of her exports over her imports, is not less than £60,000,000 per annum. £60,000,000 per annum, or some $300,000,000; so that, exclusive of Sundays, the United States must export, to pay her foreign debt, nearly $1,000,000 daily, more than she imports. Now, just as in the case of Egypt, so also have the prices of America's staple exports, wheat, cotton, maize, copper and silver fallen one half; therefore it is clear that but for that fall of prices, the burden of the external debt of the United States, upon the industries of that great debtor country, would be one half less than it now is.

SIR ROBERT GIFFEN ON THE DANGEROUS APPRECIATION OF GOLD IN 1888.

Thus the demand in the United States, that silver should be remonetised, is largely the expression of the desire in that country, that the former level of prices shall be restored, or at least that the present intolerable economic drain abroad, shall not be intensified by prices lower still. In 1888, Sir Robert Giffen, after expressing the opinion that the "recent change from a high level to a low level of prices is due to a change in money," added this truly remarkable prophecy. He foresaw "troublous times both for some of our Australian Colonies and for a country like the Argentine Republic even if the appreciation does not grow more serious. That the pile of debts has to be paid, principal and interests in appreciating money is a most serious consideration."* *Even if the appreciation does not grow more serious!* Since those words were written in 1888 gold has further appreciated 20 per cent.

CAN DEBTOR NATIONS MAINTAIN A BALANCE OF TRADE?

An economic problem then of great gravity with all debtor nations is this—namely, how, with prices perpetually falling, they can maintain a sufficient balance of exports over imports to pay their foreign debts. President McKinley hopes to do this by such a tariff as in discouraging imports will give him an artificial trade balance of sufficient dimensions. Mr. Bryan's view was that the restoration of silver to free coinage, would so raise the silver exchanges between Europe and Asia, that the exports from silver and paper communities, being no longer bonused by the depreciation of their currencies, gold prices in Europe would advance by leaps and bounds; thus the United States would both export more of her produce and get higher prices for it, so that her balance of $300,000,000 would be maintained without any difficulty—without the almost daily risk of being obliged to export gold instead of goods.

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* "Journal of the Statistical Society," December, 1888.

I am not concerned to discuss whether or no the view of the Free Silver Party in the United States is correct and scientific. Enough to say that just as the difference in 1893 between open mints to silver in India, and closed mints involved an immediate difference of some 23 per cent. in the price of silver bullion, so also the fact of open mints to silver, instead of closed mints, in a community of the predominant commercial importance of the United States cannot fail greatly to raise the price of silver. You will bear in mind also that the action of the Indian Government in 1893 in making the rupee scarce and artificially dear, cut down as if by magic, the great favourable trade balances India had for so many years enjoyed, and turned the balance of trade actually against her. With such an object-lesson as that of 1893 to guide us, I think there can be no question but that free coinage in the United States would greatly raise the rates of European exchange not only with India but with all Asia, South America, and Russia, would contract the exports from those countries until gold prices had risen, and would thus afford just that stimulus to America's exports which is needed to reduce the economic drain occasioned by low prices.

Any investigation of the present American crisis is outside the purpose of my remarks. It is enough to say that a favourable solution of the financial trouble is hardly possible so long as Europe's rates of exchange with all silver-using nations remain as low as to-day.

THE NATIONAL INCOME OF DEBTOR NATIONS.

I must now venture upon a short economic investigation, the statistics for which are very far from complete. If they were complete we should be enabled to arrive at most valuable and, I fear not infrequently, most alarming conclusions: I refer to the National Incomes of Debtor Nations. It is evident that the individuals who make up a nation, and who create the yearly wealth product of that nation, must deduct from that product enough to feed, to clothe, and to shelter them; for otherwise the human machine will become unfit for work. This then is the first mortgage upon industry. Now, the problem—a problem of immense interest—which is beginning to attract attention, is this: has the economic drain so increased as prices fall, that beyond a subsistence ration, the creditor nation is taking everything produced by the debtor? If this is the case, such a condition of wealth distribution amounts to a moral enslavement of the debtor community. An economic drain then, of any such magnitude, is not in the true interest even of the creditor nations. It is calculated to create unfriendly relations between debtor and creditor, and finally, if carried far enough, to involve debtor and creditor alike in the common ruin. Can anything then be more important, than to secure correct figures of national *per capita* incomes? Mr. Bowley has worked it out for Great Britain, in a paper* of splendid elaboration. He shows that our gross annual wealth product, animal, agricultural, structural, mineral—our wealth of all kinds, when divided by our population, gives a quotient of £42 *per capita* for every man, woman and child. Now, I take for a subsistence ration—that ration required in a climate such as ours—a little more than sixpence per day, or say £10 *per capita* per annum. Deducting this from £42, there remains a surplus available for taxation and accumulation such as I suppose the world has never known. Is this surplus being accumulated for us, by the increasing economic drain from debtor nations? In other words, does it represent an increase in the sufferings of our debtors all over the world?

THE WEALTH SURPLUS AVAILALE FOR TAXATION IN GREAT BRITAIN AND IN IRELAND.

Let me draw your attention, not merely to the magnitude of this *per capita* surplus of £32, or over £1,100,000,000 a year, but to its value—its purchasing power. The sovereign with us is worth as much, or almost as much, as it is in France or Germany; it is worth considerably more than the sovereign in our Colonies, or in the United States. The financial relations of Ireland with this country have been recently attracting much attention. The economic drain from Ireland in proportion to her resources is very great. A large part of her banking capital, of her railway capital, her shipbuilding, brewing and distilling capital, is English. Her soil is extensively mortgaged to English loan companies, and there is the drain also of rents to absentee landlords. Now, the evidence given before the Financial Relations Commission, and especially the evidence of Sir Robert Giffen, shows that the total annual wealth product of Ireland is not more than £65,000,000, or say, £14 6s. *per capita*, from which, if we deduct a subsistence ration of £10 *per capita*, or £45,000,000; £10,000,000 more for Imperial and local taxes, the surplus in the case of Ireland is at the most £10,000,000, as compared with a surplus of £1,000,000,000 in the United Kingdom. In the case of Ireland, then, there can be no doubt that after providing for the subsistence ration, and the cost of the administration, whatever remains flows into the economic drain to the creditor nation England. Perhaps the most ominous evidence given before the recent Commission was this—that the standard of living in Ireland is extremely low – even lower than that subsistence ration which I regard as barely adequate. Dr. Grimshaw, the Irish Registrar-General, speaks of ten-roomed houses where there are ten families. Other witnesses report that the diet of the community suffers, because good fresh food of all kinds has necessarily to be exported, poor innutritious foreign food being imported to take its place. We should look under such conditions for the deterioration of the human machine, for a starved cultivation and a starved cultivator.

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* "Journal of the Statistical Society," June, 1895.

AGRARIAN INCOME IN THE UNITED STATES.

Let us now cross the Atlantic and see what is happening on the farms of the United States, where again we have a community very largely dependent for the prosperity of its cities, its railways, and its creditor class, upon the profitable operations of its farmers.

According to the Census Report for 1890, the number of farms was 4,564,641; the number of people per average farm 5·8; the number of acres per average farm, 137; the gross value of the produce per farm, $539; so that we may roughly estimate that to-day almost one-half of the 70,000,000 of that population is engaged in agriculture, and if you divide the value of the produce of the farm by the number of people on the farm, you will find that the annual gross income of the farm population in 1890 was less than £20 *per capita*. Since 1890, average prices in England have fallen* 15 per cent., while the fall in the farm price of products in America has been at least 25 per cent. It is safe, therefore, to say that the present gross income of the American agriculturalist, is not more than £15 per annum, or some 10d. per day; whereas the contract cost of maintenance for paupers, in the workhouses of the United States, is returned in official documents at 14d. *per capita* per day!

And I venture to make this statement with strong conviction, that if, as the official figures seem to demonstrate, the gross income of the Irish agricultural class is now but very little lower than that which obtains in the United States, then emigration at present offers no resource to Ireland. When you take into consideration the heat of the summer, the severity of its winter season to northward of the Potomac, as also the greater cost of living on the American farm, I think that the income from agriculture should be one-half more in America than the income in Ireland, to justify the American emigration of Irish farm families.

Allowing in the case of America £10 per annum for the subsistence ration, plus £3 for the requirements of the Federal, the State, and the County revenues, there remains at present prices not more than £2 per annum, with which to support the local railway and to pay interest on local and foreign loans. There can be no doubt, that in the case of the United States, the greatest debtor nation in the world, how to meet the economic drain caused by its external debt has become an almost insoluble problem, solely because of the fall in the price of all its exports.

DISTRIBUTION OF THE WEALTH PRODUCT OF NEW ZEALAND.

Before concluding the subject of the National Income, permit me to make a brief reference to the situation of New Zealand and of New South Wales. These two splendid colonies are "separate fiscal entities;" it is therefore comparatively easy to secure reliable estimates of the economic drain, and this is not equally the case in dealing with communities such as Essex and Ireland, or such as Missouri and California. In each of these colonies is a statistical bureau in charge of a Government official; and the population, being comparatively small, the estimates of wealth production are probably more reliable than in any other country. When travelling in New Zealand, two years since, I was at some trouble to analyse from official sources the annual wealth product of the colony; and it works out, I found, at some £15,500,000 sterling, or rather over £22 *per capita* for 700,000 people. I gathered that the *per capita* returns from agriculture, including in this sheep-raising—that the returns are ten per cent. greater than in the United States; while if we allot to the American and equally to the New Zealander a subsistence ration of £10 per annum, then considering the perfection of the climate the latter enjoys, he is much better off than his fellow worker in North America. Now if we deduct the subsistence ration, for 700,000 people—or £7,000,000 sterling per annum, from £15,500,000, the total wealth product; there remains for distribution £8,500,000. Of this sum the cost of Government, including the education grant, is £2,500,000; there is also £1,800,000 of interest on £39,000,000 of public loans, borrowed in England, and there is the interest on £26,000,000 of private loans contracted in England, which estimated at 5½ per cent., is nearly £1,500,000 sterling more. If then we deduct these three items, which amount to £5,800,000 a year, from the £8,500,000 available for distribution, there remains for New Zealanders £2,700,000 only, or less than threepence *per capita* per day to reward their toil; and out of this they must pay the sea freights on their produce sent to Europe. Now but for the fall of 50 per cent. in New Zealand prices since 1873 the position of this colony would be very different. The value of the annual wealth product would to-day be not £15,500,000, but £31,000,000, from which sum (allowing for the altered value of money) deduct a subsistence ration of £20 per annum, or £14,000,000, and £5,800,000 for the cost of government and the external debt, so that instead of £2,700,000, as to-day, there would remain for the colony more than four times that sum, namely, £11,200,000.

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* See Sauerbeck's index numbers.

DEBT AND PRICES IN NEW SOUTH WALES.

I now take the case of New South Wales, which, like California, is surely one of the garden spots of the world. In population it is about equal to California, and equal also in the wealth of its resources; and probably also, if we could get at the figures for California, about equally in debt to the outer world. In Mr. Coghlan, the Government of the colony has a most talented and painstaking statistician; and these are are the figures prepared by Mr. Coghlan, when I was in Sydney two years ago. The total external payments of interest by the colony on its public and private loans is £5,100,000. The exports of the colony, which in 1894 were £15,904,961, would at the prices of 1872 have realised £29,078,000, while the imports of the colony, namely, £11,128,929, would at the prices of 1872 have cost the colony £16,819,000. Here then is a loss occasioned by the fall of prices, aggregating £7,500,000 on the external trade alone—or a yearly loss of over £6 per capita. Thus the fall of prices has imposed an annual fine upon this colony, equal to the interest on its entire external debt, and £2,000,000 to boot. You will observe also from these returns that while the colony has saved 33 per cent. on the prices at which it buys from us, its loss on what it sells us, was at the rate of 45 per cent., for the reason probably, that its sales were of raw material, and its purchases manufactured articles, in which articles labour combinations thus far, have been able to keep up the rate of wages, and thus prevent the full fall in prices.

IS THE EQUITABLE DISTRIBUTION OF WEALTH COMPATIBLE WITH RUINED AGRICULTURE?

In conclusion, let me say that in this question of the economic drain from debtor nations, which has been caused by the fall of prices, there is much more involved than the straining of our relations whether with Ireland or the United States, or than that further financial catastrophe which has overtaken our colonies. The great fall of prices, in wrecking what must always be the greatest industry employing white men—namely, agriculture—is also wrecking the entire edifice of political philosophy, which for the wisest and the best of our ancestors, was the work of their lives. For what is the ultimate aim of all political effort? Is it not the equitable distribution of wealth? And I believe that the history of mankind is witness, that the best possible—indeed the only—evidence of equity in the distribution of wealth, is to be found in the contemporary prosperity of agriculture. And it is agriculture which to-day, in this country, in Ireland, in North America, and in Australia is waterlogged because of the collapse of prices. What has been the distinctive feature of a prosperous agriculture throughout history, if not that while few in the community have become very rich, few also have been very poor? But look what is taking place with the great rise in the value of gold. While millions of white farmers are drifting to disaster, and while the great cities are congested with a "submerged tenth," driven in from the abandoned fields, there is to-day emerging a small group of millionaires, the value of their sovereigns doubled and the number of those sovereigns quadrupled.

In the United States, we learn from official returns that the average wealth of the families in the rural districts is £700, while the average wealth of the families in the cities, is nearly £2,000; and yet, in the cities, two-thirds of the families are without any property at all. Of Great Britain, a distinguished American, Professor Charles Spahr, writes, after a careful analysis of our wealth statistics: "If we sum up the results of our inquiry, we find, that less than two per cent. of the families of the United Kingdom hold about three times as much property as all the remainder, and that 93 per cent. of the people hold less than 8 per cent. of the accumulated wealth. And of America, he says: "Seven-eighths of the families hold but one-eighth of the national wealth, while 1 per cent. of the families hold more than the remaining ninety-nine."*

DISCUSSION.

Mr. R. **Manuel** said he had listened with great interest to the views put forward by Mr. Frewen, but it seemed to him that the paper was not at all confined to the influence of silver on prices, but also included some very interesting economic questions which appeared largely flavoured with socialism. Everyone must admit that the demonetisation of silver in 1873, followed by the action of England in India twenty years later, had a prejudicial effect on the gold value of silver bullion in London, the great centre of the silver trade, but he was not at all sure that it was right to conclude from that that the demonestisation of silver was the sole cause of the fall in the price of commodities. He believed there were other influences at work, which he hoped to hear dealt with by some of the eminent economists present. This paper seemed rather cosmopolitan in its sympathies, and he must confess that he looked at the matter rather from the English point of view, and according to Sir Robert Giffen it was an undoubted fact that wages generally were at a much higher level to-day than they were 25 years ago, and that change synchronised with the great fall in prices. Taking the population at 40,000,000, and reckoning five to a family, there would be 8,000,000 families of whom 1,000,000 probably belonged to the middle and upper classes, and the other 7,000,000 to the working classes, or those even not so well off; and if the result of this fall in prices was that that large section got higher wages and obtained the necessaries of life cheaper than they ever did before, he thought from a national point of view they ought to be well content with the present aspect of the silver question. He quite agreed with what had been said on the economic and social side of the question from an abstract point of view, and no doubt it was a great international question how to deal with these debtor nations. This question had nearly rent the United States in two; but it was not at all unusual for a man who had borrowed money and was called upon to pay the interest upon it to find it a drain on his resources and to look upon it as a great hardship. That was exactly the position of the debtor nations, and he did not see that it was much affected by the question of silver currency. He understood Mr. Frewen to say that if the United States were bold enough to open the mints freely to the coinage of both gold and silver at a ratio to be determined by themselves that vast and enterprising community would be strong enough to restore the bullion price of silver in gold to something nearer its old level. He believed the effect of that would be that foreign creditors would refuse to receive payment in silver, and that it would lead to draining the United States of the gold which it possessed.

Professor **Foxwell** said some of the remarks of the last speaker were very much to the point and were well worth consideration. In the first place he asked if it was right to attribute the fall in prices, which he recognised apparently as a serious evil, to the changed position of silver as money, since 1873. That was a very difficult question to answer; but it might be put in another way. What would be the effect on prices, if silver had remained in use as before; would the unlimited coinage of silver have maintained prices at their former level? He was inclined to think there might still have been some fall in prices, but that was a view which the upholders of the gold standard almost universally repudiated. They said that the world would have been flooded with silver, and that there would have been such a mass of money thrown on the market that there would have been an inflation of prices. The question was very difficult to decide, depending as it did so largely on estimates. It was often assumed that improvements in production and increased efficiency had caused the fall in prices, but he thought that could not be maintained. The question whether improvements in production would cheapen a commodity depended entirely on the other question whether similar improvements affected the production of the precious metals, which governed prices. If the improvements and inventions applied equally all round, to the commodities and the money which measured their value, there was no reason why prices should rise or fall, and that was the ideal to be aimed at. It was evident that there was no inherent necessity for improvements to reduce prices, if one looked at the period from 1850 to 1873. A leading patent agent told him that there was never a period during which more improvements were made, or more inventions applied to industry, but prices did not fall, but rose. That was the time when Mr. Gladstone spoke of the national prosperity advancing by leaps and bounds, and the reason was that while the facilities for the production of commodities were increased, the supply of gold and silver was increased still more by the discoveries in California and Australia. Another very interesting point was the relation of prices to wages. In theory, a fall of prices might operate in various ways. If the nominal wages remained the same, the workman of course got a larger share of commodities when prices fell, and that view commended itself especially to those with fixed salaries; it was the view held by the Treasury, not only here but in other countries, even in the East. But they must remember that the great majority of incomes were not fixed, but were dependent in some form on the produce of industry, and in their case it was a much more open question. Looking at the matter historically, and going back to the beginning of the century, it would be found that the condition of the working classes had been much better when prices were rising than when they were falling. One of the worst periods was from 1819 to 1849, a period during which the price of bread had a significance which in these days we could hardly understand, because when it rose above a certain point, large numbers of the people were absolutely starved. During that period, when the working classes were thoroughly disorganised, and were often out of employment, the country was on the brink of a social revolution. He had carefully studied the literature of the first half of the century, and was astonished at the mass of socialistic literature and the general discontent with which classes now quite respectable and intensely Conservative, were then permeated. A hard-working, honest man had then before him no reasonable prospect of continuous employment at a reasonable wage, and that uncertainty and sense of injustice rankled, and brought the country to the verge of revolution. At that time there was a mass of Socialistic literature which would not have been tolerated in any other country, but by 1852, when prices had begun to rise, that class of literature disappeared. He thought the evidence was conclusive that, on the whole, the falling prices from 1819 to 1849, brought with them not an increase in the real wage of the labourer, but the reverse. In 1860, Mr. Gladstone made a great budget speech, taking rather an optimistic view of the results of Free Trade, and when it was objected that things were no cheaper than before, he said it was not the question of price in which he was interested; they were going to improve the position of the labourer by freeing industry, stimulating enterprise, and so increasing employment; that, he said, was the true policy to give comfort and contentment to the labourer. The testimony of Jevons, Newmarch, and McCulloch was distinct, that the effect of the new gold and the lift it gave to prices was beneficial to all classes, and to none more than the labourers. If he thought rising prices were injurious to the labourer, or falling prices a benefit, he would never advocate anything which tended to check the fall. It was perhaps rather premature to talk about cosmopolitan views; most of them had come to the conclusion that it was not charity alone which ought to begin at home; at any rate, he was not taking the cosmopolitan view of this question of debtor and creditor, but he thought it was not to the benefit of any one that the present system, which gave an undue advantage to the creditor, should continue. He had just obtained some facts with regard to the investments of insurance companies which were very interesting. In 1892-3, he found that the insurance companies had invested about £190,000,000, at an average interest of 4·03 per cent.; and in 1895-6 their investments were £200,000,000; but the rate had fallen to 2·78, just 1¼ per cent. That was a definite illustration of the process which was going on upon the largest scale. People could not get the same rate of interest on their investments; they could get more for their money, but their incomes were reduced. It was not really to the interest of the creditor to ruin the debtor. One effect was that the overflow of British capital was checked, and it was very difficult now to find sound investments, not because the wants of the world were all satisfied, but because there was no reasonable certainty of a return on investments. He had had a deal of information lately from New Zealand, where he found this question occupied a very prominent place in the thoughts of the people, especially of students at the University. They said that to pay the debts of the colony today, they had to export 2½ times as much produce as would have sufficed to pay the same amount 25 years ago. They were beginning to declare that borrowing must cease, and it was even suggested that no one should be allowed to enter the colony who did not bring a certain amount of capital with him.

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* "The Present Distribution of Wealth in the United States," p. 69. Published by Crowell and Co., New York.

President ANDREWS (Brown University, Rhode Island) said it occurred to him, in listening to the first speaker, to inquire what proofs there might be available on the interesting question, whether the fall of prices since 1873 was occasioned by the change in the legal attitude of certain countries towards silver, or whether it might not be accounted for entirely, or principally, by improvements in methods of production. Now it would seem almost inevitable, on universally recognised principles, that if the fall in prices was caused by industrial improvements the world ought to have been much better off, strikes less frequent, and a condition of general prosperity evident, at any rate equal to that which prevailed from 1850 to 1870. But, as a matter of fact, that had not been the case; there had been a terrible depression in almost every direction. Great Britain, perhaps, had been better off than many countries, but in the United States certainly there had been no such prosperity as the theory demanded. There must, therefore, be some other cause. They were all interested in the prosperity of one another; if one nation wanted to get on, it ought to feel an interest in the wellbeing of nations across the seas, and this, not as a matter of ethics, but of economics and business. It was a great mistake to suppose that because things were in a fairly good condition in Great Britain, they were as good as they ought to be. It was very common to remark, especially at election times, that the labouring man was getting on; so he was, and he would continue to get on, because he knew enough to combine and to fight, and they must admit that, taking the world over, the working population got a little more food, a little more comfort, and a little more holiday in return for their labour; and he did not suppose there was anyone there who did not rejoice at this; but having said that, men were too apt to settle down and say, "Thank God it is so, surely we do not need anything more." The premiss was right, but the conclusion was wrong. Though the great world of toilers were fairly well off, they ought to be a great deal better off than they were; and if they could set free the springs of productive industry, the prosperity of all classes would rise to a much higher level. He did not expect the millenium would come in his day, but they might look forward to a nearer approach to it than anything seen since 1870 or 1874. There was a great deal of interest taken in the American tariff on this side of the water, and manufacturers would like to see it lowered; so should he, and he had used his influence in that direction, but the question of the tariff was intimately bound up with that of the currency. In 1886, when the Wilson Bill was before the public, he said that unless some change were made in the monetary system of the western world, and some check put on the fall in prices, Congress might put on what tariff it pleased, but it would not stand, and the prophecy was being verified much quicker than he anticipated; though the present tariff Bill might not pass the Senate. He had every reason to believe that sooner or later a very high tariff would be enacted, unless a change were made in the monetary system. How deleteriously that would act on the commerce of England, no one could say. The idea when the Wilson tariff was passed was that it would give the country an ample revenue, and it ought to have done so; but it did not, and the country went on getting into debt. The difficulty was the lack of prosperity on the part of the people, they could not purchase goods because they had fallen into a condition of poverty by reason of the monetary system. It was not to the advantage of Great Britain that there should be a high tariff in the United States, but there always would be a high tariff until some reasonable monetary system was adopted in all the western world.

Mr. W. Field, M.P., having assisted at the Conference in Buda Pest, said the majority of representatives there were of opinion that the question of bimetallism seriously affected the commerce of the world, and especially agriculture. The public mind in this country had not grasped the principle of the matter. Money ought to be the measure of value, and was there any common sense in having one currency in a certain portion of the world, representing 800,000,000, and another currency in the remainder? The practical effect was there was no money at all, *i.e.*, there was no common measure o value throughout the world. The effect was to give a premium to the silver countries, and our own manufacturers were penalised. He knew something about working men, and took the chair at a large meeting in Dublin of working men when a resolution was unanimously passed in favour of bimetallism, because they recognised that cheapness was not everything. You might have a loaf of bread for a halfpenny, but if a man had not got the halfpenny what advantage was it to him? Agriculture at the present time was to a large extent unproductive, whether in England, Scotland, or Ireland. The land did not produce one-third of what it might, and the men who were paying rent, particularly in Ireland under the monometallic system, had to pay so much more practically, because the price of all produce had gone down one-third in value. That kind of finance could not last; money ought to be the servant of mankind not the master, but the man who could command gold absolutely ruled the world. This question ought to be thoroughly studied, but unfortunately it was not fairly discussed in the Press, and politicians avoided it because it was not made a political question. He quite agreed with Mr. Bryan that until it was made a political question the people would not take an interest in it. Meantime agricultural labourers were thrust into the towns and into the workhouses. He thought it would be absolutely necessary before long for the nations of the world to hold a Conference and arrive at some principle by which the money of the world should be of equal value everywhere. If something were not done more and more goods would be imported from the silver countries, and they would be landed in something like the Chartist movement of 1848.

Mr. Hermann Schmidt said there was one phase of this question to which attention had not yet been made, viz., the absolute necessity in which the world found itself to follow the lead of England. The fact that England, France, and Germany had not seen fit to make any relaxation in their standard necessitated other nations following suit, the most remarkable instance being that of Russia, who was at present amassing gold to an amount such as had never been seen in the history of the world before. She held already more than £130,000,000 sterling, and every week she was adding to the store. There was great opposition to it by the agricultural party, but for the moment the financiers and bankers had the ear of the Government and the opponents had not been able as yet to effect anything. The question would have to be fought out, but it would probably take years, and meanwhile the commerce of the world was steadily being deprived of the gold which was being produced in Africa and Australia. Austria had commenced the same thing to some extent, even earlier, and seeing the steps Russia was taking, she was now hurrying on and taking gold in larger quantities. Japan also was following suit. It was almost incredible how a country which had run to the first position in Asia under a silver standard could suddenly adopt a gold standard, but it was simply because she thought her credit would be raised in the western world and next week she would be coming to the London money market for a loan. As had been already pointed out, the avenues of employment for capital were steadily being decreased because debtors had either become insolvent or ceased to borrow. In spite of gold being in such demand, money in the City was becoming a drug. For some time it was believed that this was only a passing phase, but when they had a 2 per cent. bank rate for two years, bankers began to recognise that the matter was becoming serious. Then came last year's panic in the United States, and in the fear that Bryan would be elected, about £10,000,000 were sent to America, which in former years would have sufficed to raise rates for a long time, but in six months the bank rate was back to 2 per cent., with little prospect of its going up. Professor Foxwell's insurance companies' figures did not nearly express the real facts of the case, because the insurance companies did not make their investments all on one day, but gradually, and they were all in possession of large amounts invested years ago, yielding still the higher rates of previous years. If they had to invest their money to-day, the figures would be very different to those which had been given. You could see this in America, where the railroads were able to borrow at 3 per cent., though not many years ago they had to give 5 or 6 per cent. That showed how the currency question affected the creditor classes. Either you must have bimetallism or capital would become valueless. Of the two alternatives, the one which made capital valuable and labour prosperous was better than the other which made capital valueless and labour idle.

Mr. E. F. VESEY-KNOX, M.P., said he unfortunately did not hear the paper, but if he might venture to criticise the title, he would say that those debtor nations which were independent, seemed to have their own way of getting rid of the economic drain. When they did not see much chance of borrowing again, they ceased to pay interest, and he did not know that he could blame them. If they attempted to pay back in gold what they had borrowed, they would be draining their country of a much greater amount than they had reckoned, and it was much simpler and, on the whole, more just to pay nothing at all. The debtor nations really in an unfortunate position were those who, not being independent, still had to pay their debts. For instance, Ireland was drained year by year, and he saw no end unless they all became bankrupt individually, there being no recognised form of national bankruptcy. Gentlemen who advocated the gold standard insisted that prices had not fallen merely on account of the depreciation in silver, and perhaps that was so. Nevertheless, prices had fallen, and consequently the debtor had to pay in commodities a great deal more than he borrowed. Owing to the English system of specific duties, the appreciation of gold had a much more oppressive effect on the poorer population in this country than in any other, where duties were only *ad valorem.* The duty on tobacco was much heavier in proportion to the value than when it was first fixed, and so with the duty on beer and spirits. That was one aspect of the financial question between England and Ireland in which England got a great advantage under the present system. Indirect taxation fell more heavily on Ireland in proportion, and the more gold was appreciated, the more England got from Ireland year by year. From that point of view, it was a pity that England could not rule the whole world as she did Ireland. If she had ruled Portugal, that country could not have got rid of her debt, and the Argentine Republic would not have been able to get temporary relief. As England did not rule all the world it would be just as well for her to take some account of the interests of those people who did not want to pay back more than they had borrowed.

Mr. MORETON FREWEN, in reply, said he could not accept the suggestion that his views were too cosmopolitan, because the whole drift of his paper was to show that we were running our own colonies, our own flesh and blood — not foreigners — into very shallow water. He did not wish to discuss the question of the relation between the fall in silver and the fall in prices; that had been argued *ad nauseam*, but anyone who wished to follow it out could not do better than refer to the evidence of Mr. Hermann Schmidt before Lord Herschell's commission. Within one week of the closing of the Indian mints, the price of silver fell 23 per cent., and there was such a collapse of prices of all kinds in the wholesale market as the world had had no previous experience of. He could not understand how anyone could dispute that if, as they were assured, the purchasing power of the rupee in India, the tael in China, and the yen in Japan was as great as ever, and yet the exchange value of those coins had fallen one-half, such conditions would not stimulate exports from the silver to the gold countries and force down prices in the gold standard markets.

He remembered Mr. Bear's figures in a paper at the Imperial Institute, on the connection between the increasing gold premium in the Agentine, and the price of wheat, which left nothing to be desired, and he enforced them by a reference to Mr. Brett's evidence before the Commission, as to the effect of the high premium on gold in the Argentine knocking down the price of wheat in Mark Lane. Exports from countries with depreciated currencies all over the world were stimulated, and the competition was such as white men here could not meet. No one denied that at some point the fall in silver must be arrested. If the United States were to demonetise silver, and throw all its silver dollars on the market as bullion, the fall in the exchanges with Asia would be such as to practically bankrupt the universe. What would the Government of India do if the rupee fell to 6d. or 3d. When this matter came into the domain of history, it would be recognised that they had, during the last 25 years, been confronted with a race issue of enormous importance to every white working man.

The Chairman, in proposing a hearty vote of thanks to Mr. Frewen, said he had for some time been strongly opposed to bimetallism, but after fifteen years study of the question he had completely changed his views, and he could not conceive how any one could maintain that the revolution of 1873 had produced no effect. He quite agreed with Francis J. Walker, whose loss they all deplored, that the history of this century would be searched in vain for a political crime of equal magnitude. He had, therefore, endeavoured to do something to rectify that blunder and remedy the effects of that crime.

General Notes.

Arcachon International Exhibition.—Information has been received from the Foreign Office, through the Science and Art Department, that an international exhibition of the products of commerce, industry, hygiene, alimentation and fine arts will be held at Arcachon-les-Bains from the 15th July to the 15th October next. The exhibition is under the patronage of the Town Council of Arcachon, and is a local enterprise not guaranteed by the French Government. Under certain conditions, the Customs duties on exhibits will be returned to foreign exhibitors. The railway companies will make a reduction of 50 per cent. upon the transport of goods destined for the exhibition. The town of Arcachon is one hour's distance from Bordeaux, nine hours' from Paris, and three hours' from Spain. All communications must be addressed to the director of the exhibition at Arcachon-les-Bains.

People's Palace.—A series of popular lectures will be delivered on Monday evenings in connection with the East London Art Exhibition at the People'
Palace. On the 31st, Mr. Wyke Bayliss, P.R.S.B.A
will lecture on "Art in England in Shakespeare'
Time."

MEETINGS FOR THE ENSUING WEEK

Monday, May 31...London Chamber of Commerce (in tl
Hall of the Skinners' Company, 8, Dowgate-hil
E.C.), at 2½ p.m., His Excellency Takaaki Kat
(Japanese Minister), "Japan and some of it
Economical Aspects."

Surveyors, Savoy-street, Strand, W.C., 3 p.m.

Geographical, University of London, Burlingtor
gardens, W., 8½ p.m. Lieut. Seymour Vandeleu
"Nupe and Ilorin (Nigeria)."

Tuesday, June 1...Royal Institution, Albemarle-street, W
3 p.m. Dr. Ernest H. Starling, "The Heart an
its Work." (Lecture II.)

Central Chamber of Agriculture (at the House c
the Society of Arts), 11 a m.

Actuaries, Staples-inn-hall, Holborn, E.C., 5 p.n
Annual Meeting.

Biblical Archæology, 37, Great Russell-street, W.C
8 p.m.

Zoological, 3, Hanover-square, 8½ p.m. 1. Pro
T. W. Bridge, "The Structure of the Skull in th
Paraguayan Lepidosiren." 2. Sir George
Hampson, "The Classification of the *Thyridid*
a Family of the Lepidoptera Phalænæ." 3. D
A. G. Butler, "A Collection of Lepidoptera ob
tained at Shoa in 1894 by Mr. F. Gillett."

Wednesday, June 2...Archæological Association, 32, Sack
ville-street, W., 8 p.m.

Thursday, June 3...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr.
D. Haviland, "Observations on Ternistes."
Prof. T. Rupert Jones, "The Genus Ramulina.
3. Exhibition of a rare Crustacean from Tasmani
(Anaspides Tasmaniæ), by Prof. G. B. Howes.

Chemical, Burlington-house, W., 8 p.m. 1. Messr
Horace T. Brown and Spencer Pickering, (i
"The Thermo-chemistry of Carbohydrate Hydro
lysis;" (ii.) "The Thermal Phenomena attendin
the Change in Rotatory Power of freshly-prepare
Solutions of certain Carbohydrates, with som
remarks on the cause of multirotation." 2. D
F. S. Kipping and Mr. W. J. Pope, (i.) "Optic
Inversion of Camphor;" (ii.) "Derivatives
Camphoric Acid. Part II.—Optically inacti
derivatives;" (iii.) "Racemism and Pseud
racemism." 3. Dr. H. A. D. Jowett, "Some ne
Gold Salts of the Solanaceous Alkaloids."

Royal Institution, Albemarle-street, W. 3 p.m. M
Chunton Collins, "William Godwin and Mar
Wollstonecroft.

Friday, June 4...Royal Institution, Albemarle-street, W
8 p.m. Weekly Meeting. 9 p.m. Mr. W.
Preece, "Signalling through Space withou
Wires."

Botanic, Inner Circle, Regent's-park, N.W., 4 p.n

Geologists' Association, University College, W.C
8 p.m.

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-squar
W.C., 8 p.m.

Saturday, June 5...Royal Institution, Albemarle-stree
W., 3 p.m. Mr. J. A. Fuller Maitland, "Musi
in England during the Reign of Queen Victoria.
(Lecture III.)

Journal of the Society of Arts.

No 2,324. Vol. XLV.

FRIDAY, JUNE 4, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

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CONVERSAZIONE.

The Society's *Conversazione* will be held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 16th June.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. In addition to this, each Member will be able to purchase additional tickets, the price of which will be 5s. each up to the day of the *Conversazione*; on that day the price will be raised to 7s. 6d. It is requested that Members requiring these additional tickets will make early application for them. Every application must be accompanied by a remittance.

Further particulars as to the musical and other arrangements will be published in the *Journal* later on.

Cards of invitation are now in course of ssue.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The fourth meeting of the Congrès Inter-ational de l'Enseignement Technique will be eld this year in London, commencing on the 5th of June next. The previous meetings of ne Congress were—in 1886 at Bordeaux, in 889 at Paris, and in 1895 at Bordeaux. The eetings will be held at the invitation of the ociety of Arts, and of the Worshipful Companies of Mercers, Drapers, Fishmongers, oldsmiths, Merchant Taylors, Vintners, lothworkers, Leathersellers, and Carpenters.

The Congress will be opened at 11 o'clock, the 15th of June, by an address from the resident, the Duke of Devonshire, K.G., and om the President of the last Congress, M. le rofesseur Léo Saignat. The meetings will be ld on Tuesday, Wednesday, Thursday, and riday, from 11 to 1, and from 2.30 to 5.

The following foreign delegates have been appointed:—Mons. Felix Martel, Inspector-General of Public Instruction, by the French Government; Mons. Eugène Rombaut, Inspector-General of Industrial and Professional Edu-Education, Professor Pyffersen, of the University of Ghent, and Mons. Wauters, Assistant-Inspector of Industrial and Professional Instruction, by the Belgian Government.

The subscription to the Congress, for others than delegates of foreign Governments, members of the Society of Arts, or liverymen of the companies subscribing, will be five shillings. This will entitle them to a copy of the report of the proceedings.

Applications for persons desiring to become members of the Congress can now be received, and should be accompanied by the amount of the subscription. In return for this a ticket will be sent entitling the members to all the privileges of the Congress.

Members of the Society of Arts and liverymen of the companies will be admitted to the meetings of the Congress on signing their names at the door.

The subjects for discussion at the Congress will include:—

Industrial Education:—

1. Advanced Instruction. Polytechnics, Universities, Colleges.
2. Secondary Instruction. Higher Technical Schools; Secondary and Intermediate Schools; Evening Schools.

Commercial Education:—

1. Advanced Instruction. Colleges; High Schools and Institutes of Commerce.
2. Secondary Instruction. Commercial Schools; High Schools; Classes for Adults.

The meetings will be held in the Rooms of the Society of Arts. Should it be found desirable to arrange for sectional meetings, accommodation will be provided in the neighbourhood.

The papers will be printed and distributed at the meetings. The reader of each paper will be allowed twenty minutes to state the substance of the paper. Other speakers will be restricted to ten minutes.

The proceedings of the Congress will be reported in English. Papers intended for the Congress may be in French, German, or English, and speakers may make use of any of these languages.

All communications relating to the business of the Congress should be addressed to the

Secretary, Society of Arts, John-street, Adelphi, London, W.C.

The Right Hon. the Lord Mayor of London has kindly expressed his intention of inviting members of the Congress to an evening reception at the Mansion-house, on the 17th of June. The Society of Arts annual *Conversazione* will be held on Wednesday, the 16th of June, and members of the Congress will receive an invitation to it. On Saturday, the 19th of June, it is proposed to organise an excursion.

Arrangements are being made to afford delegates and members an opportunity of visiting the polytechnics and other educational institutions of London.

Proceedings of the Society.

INDIAN SECTION.

Thursday, May 20; SIR H. MORTIMER DURAND, K.C.S.I., K.C.I.E., in the chair.

The paper read was—

KERMAN AND PERSIAN BALUCHISTAN, WITH SPECIAL REFERENCE TO THE JOURNEYS OF ALEXANDER THE GREAT AND MARCO POLO.

BY CAPT. P. MOLESWORTH SYKES.

The districts of Kerman and Persian Baluchistan, to which I would draw your attention this afternoon, form the south-eastern portion of the kingdom of His Majesty the Shah, being bounded on the south by the Persian Gulf, while to the east the frontier is coterminous with the limits of our great Indian Empire.

The area of the province, which is, roughly speaking, an oblong of 500 miles by 400 miles, or about as large as France, can be separated into two most distinct divisions.

The largest of these is the Garmsir, or "hot country," which, seldom exceeding an elevation of 2,000 feet, includes almost the whole of Baluchistan, and the coast regions, while the appalling desert, known as the Dasht-i-Lut, stretching to the confines of Sistan, also falls under this heading.

The south-eastern corner of the Iran plateau, which averages some 5,000 feet, and includes ranges with peaks running up to 13,000 feet and 14,000 feet, possesses, as may be supposed, quite a different climate.

Again, the entire province can also be divided into the division of waterless desert, as in the case of the Dasht-i-Lut, or of desert, with rare oases. For instance, it is impossible to travel through cultivation continuously for more than one or two miles in any part, as no crops can exist without artificial irrigation, while the water supply is extremely limited, and only obtained by digging underground channels, which tap springs in the hills. The water is sometimes conducted a distance of over twenty miles to the few acres that its vivifying influence can keep alive; and at what cost and toil these *kanats*, as they are termed, are dug and kept in repair, those who inhabit countries where the rainfall is abundant can scarcely realise.

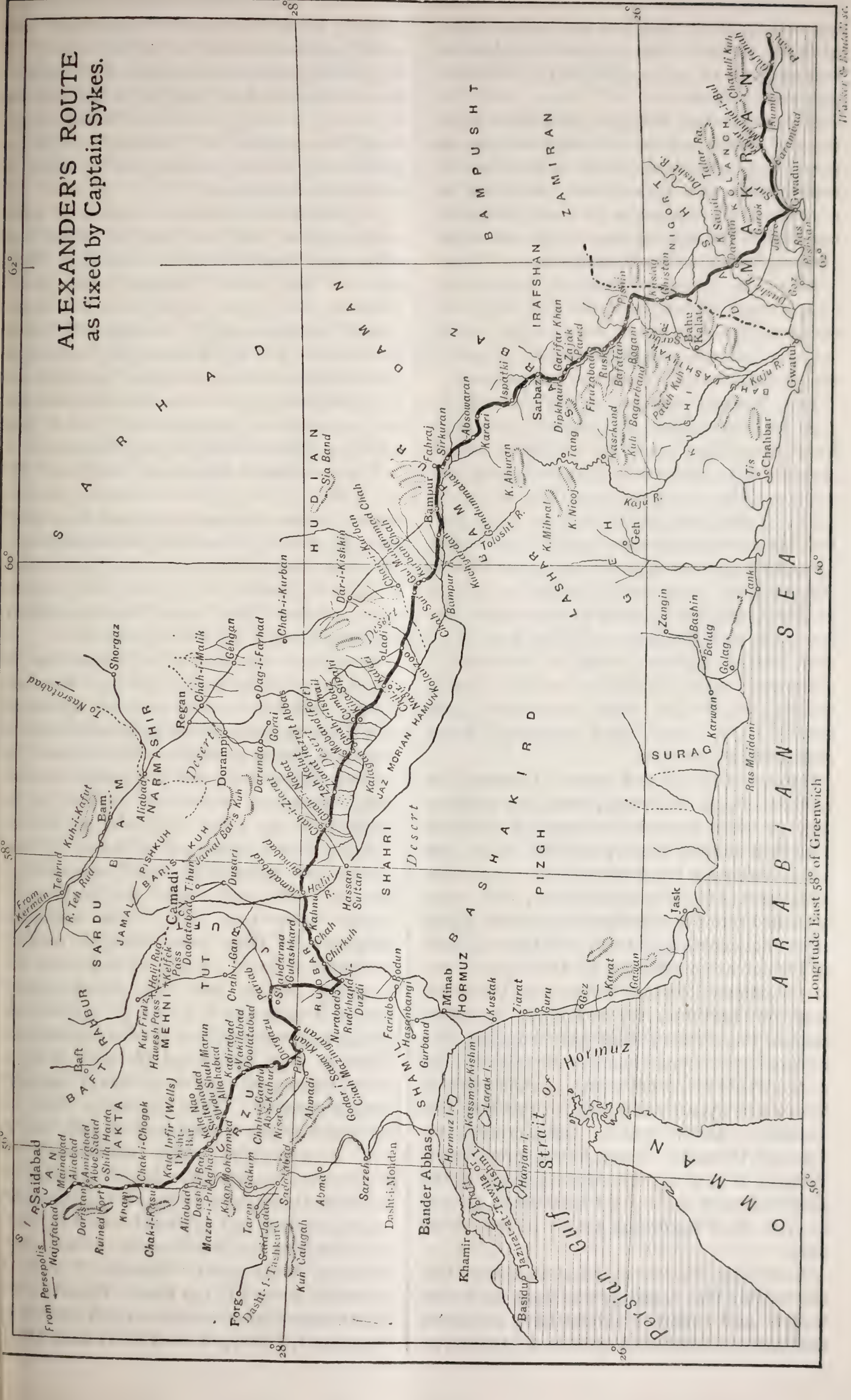
I have gone somewhat into detail in portraying the sterile nature of the province, whose huge area supports less than a million of inhabitants, as I find that most people insist on believing that Persia is a smiling land flowing with milk and honey, whereas it is in reality a most barren country, and owes more to the patient industry of its peasants than to any gifts of nature.

The inhabitants of the province are more or less a puzzle to ethnologists, especially in Baluchistan, so I will limit myself to but few remarks on the subject.

The population of the "cold country" consists of Persians in the towns and villages (a few of whom follow the ancient religion of Zoroaster), while nomads roam the desert, more or less at will, during the summer. For the winter, however, a warm district is always preferred, so that we find a constantly fluctuating population of Baluchis, Arabs and Persians, who are manlier and much wilder than the town-dwellers. They lead a life of robust ease, are very friendly, and, with Europeans, their most noticeable trait consists in an insatiable desire for medicines of all sorts and kinds.

In Baluchistan, the main bulk of the population is known by the name of Baluchis, a nomad people, possessing no literature and very few traditions. They are a quiet and inoffensive race, with a strong distaste for work, and intensely proud of being lamentably ignorant When asked a few questions as to distances or names of places, they tell you that they know nothing, and when asked how that is, reply "Why should I know? I am a Baluch!" which, if not convincing, is at any rate final There is a strong mixture of negro blood especially near the coast, which district is known as Makran.

In Sarhad there is a tribe of Kurds, who



ALEXANDER'S ROUTE
as fixed by Captain Sykes.

Longitude East 58° of Greenwich

Walker & Boutall sc.

were transported from the north-west corner of Persia by Shah Abbas, to guard his frontier, and who, not so long ago, raided almost to the gates of Teheran.

Makran, indeed, being the first point where the sea was struck by all invaders from the north, and being furthermore on the route between India and Persia, contains one of the most mixed populations in the world, thus forming a problem of great interest but one of surpassing difficulty for ethnographers.

As to the history of these regions in very early times, nothing has, as yet, been discovered that can throw much light on the subject, but investigations made elsewhere form a base for conjecture and comparison.

The Bahrein Islands, which lie off the opposite coast of Arabia, have been proved to have been the home of a culture which civilised the dwellers in Babylonia, and also to have been the great emporium where the wares of the East and West were exchanged. It is interesting to know that mention is made of these islands in sacred history, the land of Ophir having been identified with the modern El Katif, which is situated on the mainland a few miles from Bahrein, while it is from these very islands that the navy of Solomon, in partnership with that of Tyre, made the great trading expeditions, which resulted in gold, silver, ivory, apes, and peacocks being abundant in Palestine.

Captain (now Sir Edward) Durand, the brother of our Chairman, when on political duty in these regions, commenced inquiries into their ancient history, with the result that he discovered a black stone, with a cuneiform inscription of the greatest value. He also tunnelled into two of the colossal tumuli, which are so noticeable a feature in the larger island, and which are mentioned by Orthagoras, one of the companions of Nearchus, as being the tomb of Erythras, the red king, in whose honour the Persian Gulf and the Red Sea received the common name of Erythrean. As a result of his excavations, combined with those, some years afterwards, of the late Mr. Theodore Bent, which corroborated Sir Edward Durand's views, it was proved that Bahrein was, if not the original home of the people known to us as Phœnicians, at any rate, a most important centre of the Punic race.

Accepting this, we may feel sure that it is improbable that a people who were such born traders and colonists should have neglected the coasts of Southern Persia and Makran, as not only are they rich in myrrh, spikenard, and other precious herbs, but in the infancy o navigation, instead of, as now, being able to keep the sea without touching at any port for supplies, a landing had to be effected almost daily for purposes of watering, while n mariner would ever venture out of sight o land if he could help it.

In Baluchistan, the only remains of great antiquity that we can point to, consist o what are locally known as *damba.* These mounds have been described by Colone Mockler in a paper read before the Roya Asiatic Society in 1877. It is impossible to g into detail, but his account will suffice t show that the ruins he describes possess great similarity to those discovered in Bahrein and we may thus fairly conclude that it is a least possible that their origin is identical.

We were much interested, in 1896, to fin at Jalk, and in the surrounding district several tombs of a very much later date, whic resembled these two-storied Phœnician sepulchres, but these will be referred to later on, an I will now proceed to the events of the fourt century before Christ, where our knowledge i based on history of a reliable nature.

Owing to the exploits of Alexander th Great, whose fame is deathless in the East Persia and Baluchistan are most accurate described by many Greek historians, of whom Arrian is *facile princeps.* As Gedrosia, th modern Baluchistan, and Karmania, now Kerman, occupy a prominent position in th account of the great soldier's march fro India, I have read the authorities on the spo during my wanderings, and attempted t trace the exact route that the world's conqueror followed—a task which insufficien geographical data have hitherto rendere somewhat difficult. The best and latest description dealing with his march throug British Baluchistan is found in a lecture delivered before the United Service Institution o India in 1894, by Colonel Holdich, R.E., t whom I would offer my best thanks for muc kind assistance. This, however, does no carry the reader beyond the British frontie and consequently, after summarising th arguments leading so far, I propose t describe Alexander's journey on its westwar course, hoping that my local knowledge ma add a little to the identification of the countr traversed by the great "Sikunder," as he i invariably termed in the East. For reference to Arrian and other ancient writers bearing o the subject, I have, in every case, used Mr. J

W. McCrindle's "Invasion of India," and his "Erythrean Sea," which contain, all the text of the various historians, and are elucidated by masterly notes on many doubtful points.

Before approaching the actual narrative, it is interesting to review the events which fixed the limit of conquest for the Greek army. After entering India through the ivy-clad hills north-east of Peshawar, which have been identified with the Nysa of Arrian, Alexander crossed the Indus without any difficulty, and advanced to the Jhelum, where he was encountered by Porus, of immortal fame. From the Jhelum, a line passing near the towns of Lahore and Amritsar was followed, until the last of the five rivers that give the name of Punjab to the district, was reached. The Greek soldiers, although marching from victory to victory, were sated with conquest, and when the capture of Sangala was effected with extreme difficulty, and at the cost of over a thousand killed and wounded, it was felt that the limit of their advance had been reached. Upon arriving at the banks of the Beas, the classic Hyphasis, beyond which lay an extensive desert, Alexander saw that, before crossing to the basin of the Ganges, he must find out what support he could reckon on from his army. A spirited harangue, however, made little impression upon the worn veterans, who were probably only anxious to spend at home the large fortunes that they had amassed at the daily risk of their lives, and after waiting for three days in the hope of seeing a change in their usually impulsive minds, the great commander permitted himself to yield to the wishes of his soldiers, and the return journey was ordered.

Embarking somewhere near Jhelum, on the river of that name, the army and fleet kept in touch during the whole of the long journey to the delta of the Indus, which may well have occupied the best part of a year. At any rate, we know that it was about September, 326 B.C., that Alexander temporarily left his Admiral, Nearchus (who was enjoined to await the end of the monsoon), and the disastrous journey through Gedrosia was commenced.

Most writers on Alexander appear to be somewhat at a loss to account for his choice of such a desert route. Craterus, with the elephants and baggage, apparently met with no special hardships, and safely rejoined Alexander when the latter had "arrived in Karmania," by what was evidently a well-known route. The extraordinary policy of marching an army through the desert arose, in all probability, not from any wish to rival Semiramis and Cyrus, as Arrian makes Nearchus assert, but from the necessity of supplying his fleet by means of his army. This operation, rendered necessary by the poor quality of the vessels, constructed by no shipwrights, but by the rough hands of soldiers, and not fitted out at any port, must surely have been the reason why Alexander did not take the route followed by Craterus, but faced the dangers of the desert, of which he knew full well the gravity, rather than let it be said that he deputed a task to a subordinate which he dared not carry out himself.

The country of the Arabitae and Oritae, near the modern Lus Bela, produced a sufficiency of provisions, and, after collecting them, Alexander marched south-west to the coast, where he again met the fleet, and was able to victual it for twenty days. His progress along the seashore was now checked by the Malan range, which abuts on the sea, and, although anxious to a degree about his fleet, which, one would have thought, was better off than the army, an inland route was perforce followed, involving the horrors of heat and thirst. Colonel Holdich considers, and indeed proves, that the awful sufferings endured by the army were concentrated into this section of the journey—a distance of some 200 miles. The description of Arrian might have been written by a modern traveller, and powerfully appeals to any one who has journeyed in Makran during the month of October. He says:—"They met with lofty ridges of deep sand, not hard and compact, but so loose that those who stepped on it sank down as into mud, or rather into untrodden snow . . . . When they traversed by night all the stage they had to complete, and came to water in the morning, their distress was all but relieved. But if, as the day advanced, they were caught still marching, owing to the great length of the stage, then suffer they did, tortured alike by raging heat and thirst unquenchable."

During my march from Chahbar to Geh, in October, 1893, the heat in the shade was daily over 90°, and sometimes over 100°; while forage and water were almost non-existent. If the hopeless feeling engendered by not knowing how far the next stage is, by seeing one's horse too tired to be able to do anything except drag himself along, be considered, then the horrors of the situation for men marching in heavy armour across the stony passes, or, even worse, ploughing their way through the deep sand, can be fully realised. As if matters were not bad enough, a *seelab*, or flood — so dreaded throughout Baluchistan—added to their misfortunes.

Here, again, I cannot do better than quote Arrian :—"When the army on one occasion lay encamped for the night near a small winter torrent for the sake of its water, the torrent, which passes that way, about the second watch of the night became swollen by rains which had fallen unperceived by the army, and came rushing down with so great a deluge that it destroyed most of the women and children of the camp-followers, and swept away all the royal baggage and whatever beasts of burden were still left." Many are the proverbs current in Baluchistan, which show the dangers of sudden rushes of water. One of the best is, "He who stops to tie his latchet in the Mashkel is a dead man." A *seelab* is a fine sight if one is in safety. A sudden roar, followed by a foaming torrent, and a great river is flowing, in what, a few minutes previously, was a dry watercourse. This flood may have been caused by rain that had fallen a hundred miles away, so that no wary traveller ever camps in a river bed if he can avoid it.

Having, at last, passed the most westerly spur of the Malan and Taloi ranges, the road to the coast was again open, and Alexander passed on ahead of his army by the nearest and only practicable route, which brought him out at Pasni. There he must have found sweet water within three feet of the surface, and the army was saved.

Seven marches along the coast, averaging some twelve or fourteen miles, would bring the Greek troops to the modern Gwadar, which is now the sole possession left to Muscat on the northern coast of the Arabian Sea.

At the present time, it is interesting to know that practically the entire import and export trade of Persian Baluchistan is carried on through this port.

The reason for adopting this far from direct route lies in the fact that it is the only line of communication leading from the coast to the interior that can ever be described as fair. All the other tracks continually cross ranges at right angles, or else include a nearly impracticable pass, as was my case when travelling from Geh to Bampur. The Gwadar-Bampur route, however, mainly lies up the bed of the Dasht river to some distance about Sarbaz, whence the watershed, by which the Bampur basin is entered, is quite easy.

The first town mentioned, as being sufficiently well provided with supplies to warrant a long halt, is called Pura, the same as the word "Por," affixed to so many Indian words signifying a town, *e.g.* Sultanpor, Jubbulpor. The late Sir Oliver St. John, who was among the first to identify ancient sites by local knowledge, fixes this town at the modern Faraj, some twenty miles north-east of Bam, where there undoubtedly are remains of great antiquity. His argument is mainly based upon the fact that Alexander "arrived there in sixty days after he had started from Ora." As the journey from this district, on the shore of which he had left the fleet, to Fahraj (near Bam) would be about 600 miles, this gives a daily average of ten miles, which Sir Oliver St. John thought a fair rate of marching. We must, however, recollect that Alexander's constant preoccupation was the question of the safety of the fleet, so that it is probable that he would not care to march further inland than was absolutely essential.

To the east of Bampur is a second Fahraj or Pahra, the Persians using the former, and the Baluchis the latter pronunciation. This village, which is once again the capital of Persian Baluchistan or Gedrosia (the words are identical according to some authorities), is certainly on Alexander's line of march, and being but 400 miles, or perhaps, a little less from Ora, gives a daily average of between six and seven miles for the sixty days.

Most travellers in Baluchistan will agree that this, for an army worn out with hardships, and encumbered with women and booty, is a fairer estimate than ten miles a day including halts.

Again, however, the map is our best guide, and by carefully examining it, and bearing in mind Alexander's intense anxiety about the fate of his fleet, one is forced to the conclusion that from the Bampur basin, Alexander travelled due west to Rudbar. By moving north-west to the Fahraj near Bam, and then south-west to Rudbar, two sides of a triangle would have to be traversed, with loss of time, excess of fatigue, and but small chance of gaining any intelligence as to the fate of the fleet.

On the other hand, he would learn that Rudbar was but five marches from the sea, and was an extraordinarily fertile district, and also that between Gedrosia and Rudbar, water and supplies would be abundant. It is certainly to be regretted that at Pahra (near Bampur) no discoveries have been made which would afford an undoubted proof of the passage of the Greeks; but it is confessedly the most ancient site in the country, and although my promises of backsheesh produced absolutely nothing in the way of curios, yet there were several most promising mounds which I longed to excavate, and, of course, all Greek relics must be many feet underground.

In 1894, my party was the first to follow what, I would venture to claim, was the route selected by the Greek leader. Upon leaving Pahra or Fahraj, we followed the Bampur river to where it mingles its waters with those of the Halil Rud. Throughout the entire journey from Bampur to Rudbar, a distance of more than 150 miles—although to-day the only population consists of a few nomads—there were remains of villages and forts, that eloquently pointed to departed prosperity.

To return to Alexander's march. We must remember that as the onward journey was made during January, the coldest month of the year, a route possessing the advantage of lying through a district which is entirely "hot country" — would naturally be preferred to one where snow is frequently the order of the day—Rudbar evidently then, as now, was a district in Karmania, and it was there that Craterus, with the heavy baggage joined his master, who had formed a standing camp, upon reaching the fertile valley of the Halil Rud. It is in this district, then, that Alexander halted, while enquiries were being made in every direction for the fleet, of which there had been no news for so long. Its gallant commander, Nearchus, however, after enduring considerable privations, had, in the meanwhile, safely arrived at Harmozeia or Hormuz, on the Mináb river, and hearing the glad news that his royal master was a few marches inland, hastened to meet him with a very small *cortège*.

Few incidents in history are more dramatic than the meeting between Alexander and his heroic admiral. News of a prosperous journey had indeed been brought by the local governor of Harmozeia, but, no confirmation being received, it was held to be false, and the unhappy official was thrown into chains. The arrival of Nearchus and his few companions weather beaten and in rags, while proving their individual safety, shattered all the lingering hopes of their royal master, who deplored the loss of his subjects most bitterly.

His joy must have been overwhelming when the good news dawned upon him, and we can well understand with what fervour he sacrificed to Zeus the Preserver, and to Poseidon, the God of the Sea.

Before quitting this subject, I propose to make a short reference to the route taken by Craterus.

At the present day there is no caravan route of any importance leading from India to Southern Persia. The fact that until the last few years no Europeans could travel in the country except at considerable risk, while raids are still not quite a thing of the past, would account for much; but other causes are still more potent. In Alexander's day the sea was feared, and with reason, to a degree that we can hardly realise nowadays, and it is clear that a journey by land was considered safer and in every respect more desirable in spite of the numerous perils accompanying it. On the contrary, ever since the discovery of the Cape route, sea transport has possessed such unquestioned superiority over transit by land that routes, well-known before the advent of European ships to the East, have been entirely lost to sight. This is very much the case with the road followed by Craterus, but yet we have something to work on.

To begin with, in chapter xv., Arrian reads as follows:—"Craterus he again despatched with the army (through the country of the Arachotians and Drangians)," and again, in chapter xvii. we read:—"He sent away Craterus into Karmania by the route through the Arachotians and the Sarangians." Add to this the result of the excavations at Quetta, in connection with the building of the fort, which brought to light a Greek bronze of Herakles, which now rests in the Bengal Asiatic Society's Museum at Calcutta. We may thus fairly take Quetta as a fixed point, to use the survey term, which would be reached viâ Kalat, or the Bolan Pass, probably by the latter if, as the text would show, Craterus was despatched before the delta of the Indus was reached, while it is more likely that there would be a halt and an opening of baggage after threading the defiles of the Bolan, than if the army had marched in by the easy road running from Kalat, especially if we recollect that Quetta was not a town, so far as we know, at that period. Kandahar, which had already been visited, and was under the Satrap of the Arachotii, would be the next important town upon his route.

From Kandahar the River Helmund was undoubtedly followed to the *hamun* or lake which received its waters a little to the south of modern Sistan, as the river in ancient times discharged into the Gaud-i-Zirreh, instead of swinging round to the north, as at present. In any case Ladis (where I have heard that there are considerable ruins) on the Tahlab river was the most probable point for Craterus to make for.

From Ladis onwards, my local knowledge inclines me to trace his route nearly due west, through the parallel east and west ranges that were visible from the summit of Koh-i-Taftan or Chehel Tun when I climbed that peak in 1893. The open desert then lay between the Greek army and Narmshir, their route leaving the Basman range on the south. As we may suppose that this track of only some ninety miles was crossed about the beginning of January, there would be a certain amount of water all along the route at that time of the year, and it is more than probable that, being a trade artery, there were small hamlets scattered about, or at all events, nomads feeding their flocks of sheep as at the present day. The difficulty of marching is not very great during the winter months as, in this portion of the desert, water of a fair quality and grazing is generally found.

We can fairly assume that Rigan was the village struck after traversing the desert, Fahraj being quite out of the way in the case of travellers bound for Rudbar. From Rigan to Rubdar there is a road which is perfectly open all the year round, its greatest altitude barely exceeding 4,000° while the gradients are easy throughout. This is undoubtedly the route selected by Craterus as being the only practicable one. Nothing except the words, "When Alexander arrived in Karmania Craterus joined him," are written to guide us; and it may be objected that it is but waste of time to trace out imaginary routes without any proper proofs. This I would contest, for if Craterus did not take the Helmund line from Quetta he must have proceeded down the valley of the Rakshan to Kohuk, Dizak, and Magas. Had he done so he would have joined Alexander at Pahra or Fahraj in Gedrosia, and not in Karmania, as is clearly laid down. Between these two routes lies the desert, which the recent experiences of the Baluch-Afghan Commission show, is not suitable even for a small party to travel across. I would, however, only claim that the route followed by Craterus is approximately the one I have outlined, while future discoveries will, it is to be hoped, place the facts beyond doubt.

For the onward journey to Pasargardæ, the map will show that the most likely route is that one which runs through Sirjan, after which Baonat and the royal city are reached, and here bid farewell to this interesting page of history as the Greek army has marched beyond the limits of Kerman.

After the death of Alexander, darkness again settled on South Eastern Persia, which became in time part of the Parthian Empire. This great power, which successfully crossed swords with the Roman legions, lasted approximately from the middle of the third century B.C., to the third century A.D. We then read that Ardeshir, son of Babek, a scion of the old Achaemenian race, and Satrap, of Fars, captured the town of Kerman, and finally established what is known as the Sassanian dynasty.

In this connection I would refer to Shehr-i-Babek, to the west of Kerman, which is considered by the Parsis to be founded by Ardeshir's father, Babek, while an ancient name for the district of Kerman is Kwashir, or Kureh Ardeshir, meaning the district of Ardeshir. This royal race flourished until the religion of Mohamed arose, when the Arabs, newly-converted from depths of degradation to the knowledge that there was but one God, overran Persia, during the Caliphate of Omar, about the middle of the seventh century. Curiously enough, one of the first *reflet* tiles that we found at Kerman, bears the inscription, "Hail Omar."

The last of the family of Sassan, Yezdigird III., when his troops were finally defeated, fled to Kerman, where he ruled for a few years until he met his death at the hands of a servant, who murdered him for the sake of the jewels and money he had in his possession.

During the next half-century the provinces of Kerman and Baluchistan were overrun by the Arabs who, according to a universal tradition, planted the date-groves of Makran by throwing away the stones of the fruit that they had brought with them from their own country. In any case the magnificent dams known as *ghorbasta** which still exist throughout Baluchistan, are the work of this great nation, whose ships were the prototypes of all European fleets, and whose buildings to this day are worthy monuments of a race that is still the most manly of Eastern people. In Makran, indeed, the power of the Arabs was not a

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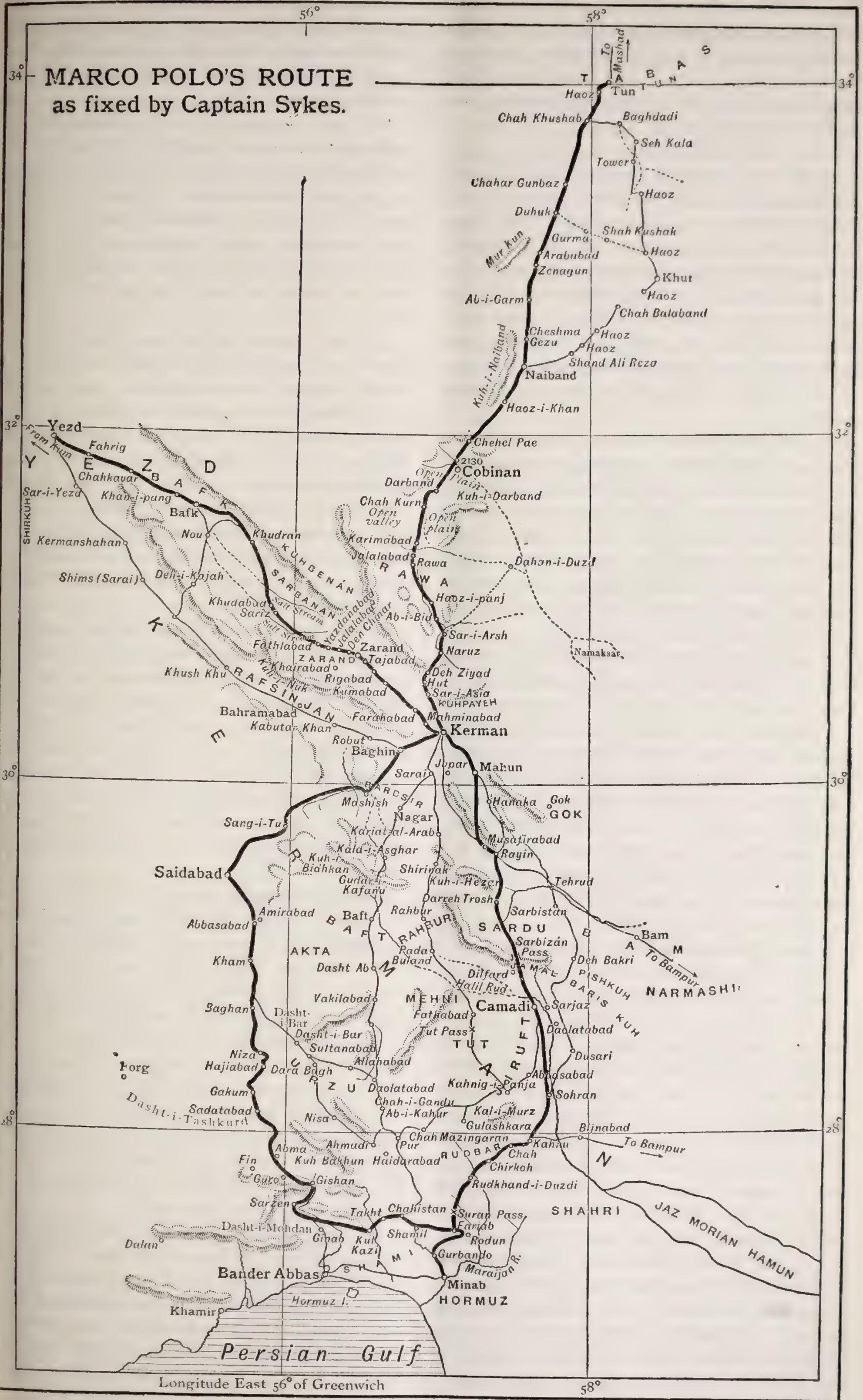
* "Ghorbasta" or "the building of the infidel." Any one not a Mohammedan, or any one of whom the Baluchis have no records are termed "ghor," which is the same word as "giaour" applied to us in the time of the Crusades. Hindus are thus called in Baluchistan nowadays.



MARCO POLO'S ROUTE as fixed by Captain Sykes.

Walker & Boutall sc.

thing of the past, even when Bagdad fell, while until a very few years ago, Chahbar, which is near Tiz, their largest and most flourishing port in mediæval times, was independent and under its own chieftain.

The whole of Persia then was but an appanage of the Caliph of Bagdad until Hulagu Khan, grandson of the great Chingiz Khan, overthrew their rule, after which the Mongols were the supreme power in Asia. This occurred during the thirteenth century, but long before the great republic of Venice had been engaged in an overland trade which was carried right across Persia, through Kerman to Hormuz, the port where Nearchus and his fleet found shelter on the Minab River to the east of Bunder Abbas.

So great was the influence of this commerce that, as late as this century, we read that Lieutenant (afterwards Sir Henry) Pottinger, the first explorer of Baluchistan, took, as he quaintly puts it, a "store of Venetians" with him, when he started forth on his travels, while the only gold coin that I found in the country was an Oriental imitation of a ducat bearing the stamp of the great Republic.

It is at the latter end of the 13th century that the illustrious Marco Polo appears on the stage and, as he honoured Kerman twice by his presence, it is but natural that my efforts should have been directed towards elucidating the several points that imperfect local knowledge rendered somewhat obscure. I propose, therefore, to take up the great explorer's tale, and travelling by the same routes that he has followed, I hope to add just one more link to the chain of identification that the last decade has seen so swiftly forged.

We will commence upon his departure from Yezd, giving Marco's own words, from Sir Henry Yule's great work, wherever necessary:—"When you leave this city [Yezd] to travel further, you will ride for seven days over great plains, finding harbour to receive you at three places only. There are many fine woods (producing dates) upon the way, such as one can easily ride through. . . . There are also some wild asses, handsome creatures. At the end of those seven marches over the plain you come to a fine kingdom, which is called Kerman." This portion of Messer Marco's journey is easy to trace for the following reasons. There are but two routes from Yezd to Kerman, along both of which I have travelled, but only on the northern route is the altitude low enough for dates to grow, while at Bafk, to the present day, there are extensive groves of date palms. The altitude of this town is 3,100 feet, while on the southern route, once Yezd is left, there is not a single portion of the road under an elevation of 4,000 feet.

This would appear to be conclusive, but, in addition, it may be mentioned that along the southern road there is no likely wild ass country, to use a sportsman's term. In Persia these "handsome creatures" are invariably found near salt swamps known as *kavir*, none of which are met with on the southern route, with one exception, and that an insignificant one.

If I might make a guess as to the "three places only at which you find harbour," I should select Balk, Khudran, and Zarand. At all these stations, and at no other, is there running water, which is at least remarkable. At Khudran, which is situated in a narrow valley down which runs a mountain stream, there is the biggest *chinar*—the *arbre sol* of Marco—that has ever delighted my eyes, and it is interesting to think that it may have been a young tree, and afforded shade to our traveller in the 13th century.

I think, then, that as far as Kerman, there is no doubt as to our traveller's route; so we will proceed to give his description of that ancient city:—"Kerman is a kingdom, which is also properly in Persia, and formerly it had an hereditary prince. . . . . The ladies of the country and their daughters produce exquisite needlework in the embroidery of silk stuffs in different colours, with figures of beasts and birds, trees and flowers, and a variety of other patterns."

Before commenting on these lines, it may not be out of place to give a short description of Kerman as it was at the beginning of the 13th century. The city was built round the base of two hills, on both of which there were forts that are attributed to Ardeshir, but which are probably very much older. In the plain between them, there was a magnificent mosque, adorned with *reflet* tiles of turquoise and sapphire blue, while close by were buildings of great splendour, with mosaic pavements and tiles of every hue, the very lattice-work of the Anderûn, or women's apartments, being iridescent with lustrous colour.

Towards Mahun, to the south-east, the Naghalkhana or Bandstand is hewn out of the solid rock of a peak, which overlooks the town, while to the north lay the two gardens of Ziris and Fermetun. Between them was what is known as the Jabal-i-Sang, with the inscription, "I have been built between two

Paradises." This curious building, which will appear on the screen, is apparently of Arab construction, and is now stripped of all its tiles, the last of which fell off some five years ago.

As to the forts themselves, we never discovered anything of interest, except bits of mosaic pavement, a stone with an inscription in cufic character, and a receipt for forage dated some 600 years ago, together with a complaint that looting has occurred in the Jabal Bariz district.

At the time of Marco Polo's visit, the province was ruled by a Kara Khitanian dynasty, of which Torkhun Khatun, a lady of great character, was the most active member. It is recorded that she married two ruling princes and killed her brother, but the avenger of blood finally overtook her, and she was put to death by her sister-in-law and niece. However, she is not forgotten, as the Kubeh-i-Subs, one of the oldest edifices in Kerman, still survives to perpetuate her memory. It is a high-domed building, and was covered with bluish-green tiles, whence its name of the green dome. Inside there is a good deal of gilding, and I was fortunate enough to secure the following inscription (640 Anno Hejra or 1242 A.D.) :—

"The work of Ustad Khojeh Shukr Ullah and Ustad Inayet Ullah, son of Ustad Nizam-i-Din, architect of Isfahan."

The date of 1242 A.D. is probably the year in which it was commenced; so it was completed, one would think, before either of Marco's journeys, and we can only regret that he drew no attention to it.

At the beginning of this century, the structure was intact, but, unfortunately, a governor heard that treasure was buried underneath the walls, and so pulled down half of it.

It is interesting to note nowadays that it s only at Kerman that "figures of beasts and birds" appear on the carpets, such patterns, which are evidently of great antiquity, being against the tenets of Mohammedanism.

We cannot, however, linger at Kerman, but must accompany our traveller on his journey owards Hormuz. He says:—"On quitting he city, you ride on for seven days, always finding towns, villages, and handsome dwelling-houses, so that it is very pleasant travelling . . . . . When you have ridden those even days over a plain country, you come to a great mountain; and when you have got to he top of the pass, you find a great descent, which occupies two days to go down. . . . . From the city of Kerman to this descent, the cold in winter is so great that you can scarcely abide it, even with a great quantity of clothing."

During the summer of 1895, I made a tour into the plateau region, lying to the south of Kerman, so as to be able to investigate this question of Marco's route, by travelling over the district which has never been revisited since the great Venetian's journey. I had already, during the previous year, travelled from Jiruft by the Deh Bakri pass, across the Jabal Bariz range, which is now the caravan road; but as Marco distinctly refers to a "plain country," the pass of Hanaka, which is crossed at an elevation of 8,300 feet between Mahun and Rayin, would certainly be inapplicable, although the remainder of the distance fits in very well, except that there is no "great descent," but rather a series of small passes, each one lower than the other, when travelling south. Bearing these facts in mind, I made inquiries as to whether there was no other route between Mahun and Rayin, with the result that I found that the Hanaka route was a new road, its caravanserai dating from the present century, whereas the ancient route, which entered the hills just above Mahun, did not necessitate crossing such a difficult pass as that of Hanaka.

In consequence, I travelled by the latter road, and found ruins of caravanserais at Sang (about 18 miles from Mahun), and again at Ab-i-Gaz, about four miles from Rayin. The pass, however, I am bound to state, rises to an altitude of 8,600 feet, and is thus rather higher than the Hanaka road, although less noticeable. A third alternative would be for the traveller to skirt the Jupa range, by which means he would, at the expense of a small detour, reach Rayin without leaving the plain.

In any case, after quitting Rayin, Sardu, or the "cold country" (which name fits in excellently with the description), is entered.

First of all the traveller crosses to the south side of a plain some fifteen miles wide. He then passes through a low range by a very easy road, and after crossing some streams that rush down from the Kuh-i-Hezar, finds himself at Darreh Trosh, having risen 2,000 feet since leaving Rayin, and probably having taken two days to accomplish the distance.

The following day the plateau is crossed to its southern edge, and Marco probably stopped for the night at the caravanserai near the pass, of which only the ruins are left to mark the spot. This Sarbizan Pass has an altitude of 9,050 feet, and we much enjoyed the coolness of the climate and the green look of the country, while from one of the peaks of the Dilfard range to the west, the plain of Jiruft was distinctly visible almost at our feet. To continue, from Sarbizan the "great descent" begins, and so steep is the road that at Dilfard, about seven miles below the summit of the pass, the altitude is only 5,800 feet—a drop of over 3,000 feet.

Altogether it would be about thirty miles to Camadi, a fair two days' march when the precipitous and stony nature of the way is taken into consideration. This then, I would urge, is the route which Sir Henry Yule was waiting for an account of, as he writes in his notes, and I think that I am correct in stating that it is the only one which tallies with the text.

To proceed, Marco says:—"After you have ridden down hill these two days, you find yourself in a vast plain, and at the beginning thereof there is a city called Camadi, which formerly was a great and noble place, but now is of little consequence, for the Tartars in their incursions have several times ravaged it. The plain whereof I speak is a very hot region; and the province that we now enter is called Reobarles."

As to the site of the city of Camadi, which is in "a very hot region" above Reobarles, I think that Sir Robert Murdoch Smith's identification of it with the Dugiyanos, or ancient Shehr-i-Jiruft is not to be doubted.

Some time was spent by me, in 1894, encamped on its ruins, where we found that the plain was thickly covered with kiln-burnt bricks, some 8 inches square, for a very large area. At one place we could trace the remains of what we were told was a ditch surrounding the fort, and everywhere we picked up bits of pottery and plaster.

The nomads, who find signets, beads and coins after every fall of rain, brought them for sale in considerable quantities.

We have now brought our traveller to the very same valley in which Alexander encamped while trying to gain news of Nearchus, and it is interesting to note that, during the interval of more than 1,500 years, no European had passed through those regions.

As to the derivation of Camadi, I would suggest that as Kamr-asal and Kamr-zar are names found close by, so why not Kamr-deh, "deh" meaning village? I submit these points for discussion, but I fear that I am too ignorant to offer any opinion on this question.

The onward journey presents no difficulty, the traveller passing across the plain of Rudbar to the Minao or Minab river, on which the ancient Hormuz was situated, before it was removed to an island off the coast.

We will now follow Marco's example and return with him to Kerman, the route to which town has, I believe, been fixed by General Schindler, one of the greatest living authorities on Persia, as passing through Saidabad, the capital of Sirjan. In any case that is the route invariably followed by caravans in winter, and there are numerous sulphur springs near the Koh-i-Ginao, so that, although the indications are very vague, it is almost certain that this is the road, from his mention of the sulphur springs.

We will now let our author speak again. He says:—"On departing from the city of Kerman, you find the road for seven days most wearisome; and I will tell you how this is. The first three days you meet with no water, or next to none, and what little you do meet with is bitter green stuff, so salt that no one can drink it. . . After these three days of desert you arrive at a fresh spring of water running underground. . . . You then enter another desert, which extends for four days; it is very much like the former, except that you do see some wild asses. At the termination of these four days of desert, the kingdom of Kerman comes to an end, and you find another kingdom which is called Cobinan."

A reference to the notes in Sir H. Yule's work will show that nothing certain is known about this portion of the journey, the only indication being that "Cobinan" was to be found in the modern district of Kuhbenán, which is a hilly and fertile part of the country ying N.N.W. from Kerman.

In 1893, when travelling between Mashhad and Kerman, I crossed the Dasht-i-Lut, and I have reason to believe that, I was the first European to traverse it from north to south. I would, therefore, attempt to give the following elucidation of the text. Firstly, I think that, in identifying the route of Marco Polo, we should begin by seeing whether the present caravan road will not fit in with the text. In this particular case the position of Cobinan is of supreme importance, and the site of this town I believe that I have discovered. When at Darband, about a hundred miles from Kerman, on the Khorasan caravan route, I inquired the meaning of its name of "Darband," or "shut door," and was told that the daughter of the King of the Desert City had fled from home with her lover, called Dargha, and had built two forts on a ridge that commanded the road, and had also placed little towers in all directions, to prevent any travellers from evading the tax that she levied on all passers-by.

In proof of this, I was shown the remains of the two forts, of the wall that shut the road, and of the little towers in the hills.

My next question was, who was the king, and where did he live? My informant then told me that he was a king who lived in the City of the Lut, close to which I had passed on the previous day. I had, indeed, noticed some ruins to the east of the road, but, as anyone can imagine, after crossing the Dasht-i-Lut, my pony was not in a fit state for much deviation from the beaten track. I was told that the city had been abandoned, because its water supply gradually became so brackish that it could no longer be drunk, and that there were signs of fruit trees and gardens all run wild.

This, then, is the probable site of Kuhbenan, which, formerly a province, has now shrunk so that the name only applies to the comparatively small district to the north of Zarand.

Supposing, however, that we do not accept this, let us examine the alternative routes. If Marco had travelled by the modern Kuhbenan, in the first place, he must have retraced his steps along the same road by which he came from Yezd, and this he would most probably have mentioned.

Secondly, the modern Kuhbenan is very hilly, almost impassable for caravans, and is an upland country abounding in pasturage and springs of excellent water.

This, then, cannot be the route referred to in the text. Again, we cannot follow a more easterly route, for the same reason that if we travel through the district of Kuhpaieh we are again in high country while owing to the difficulties of the road the whole district was a blank on the map until I gave it its geographical existence in 1893.

We may, then, fairly accept the present caravan route, as that followed by the illustrious Marco and, as three marches from Kerman, one finds at Sar-i-Arsh, the only brook that exists between Kerman and Herat, the fact is striking. It must, however, be mentioned that this brook does not run underground, but as this is a statement of Ramusio, we may well believe that it applies to some other place, or in fact, to most other places, but certainly not here, and that Ramusio who had heard Marco describe *kanats*, thought he ought to mention the fact, and was not particular where he added the gloss.

Four marches further on is Cobinan, but although the country passed through is strikingly sterile and salt, at Rawa there is nowadays a large oasis fed by *kanats*, which may not have existed six hundred years ago.

If the *kanats* were not dug the plain would be as sterile as elsewhere, but I have a vague recollection that mention is made of Rawa very shortly after this date. With this exception the route fits in admirably, while the description of the water cannot be bettered. As to the products of this city I was shown a mine of asbestos, while copper is said to be abundant. We must, however, move on, and for the last time quote our author:—"When you depart from this city of Cobinan, you find yourself again in a desert of surpassing aridity, which lasts for some eight days; here are neither fruits nor trees to be seen, and what water there is is bitter and bad, so that you have to carry both food and water. The cattle must needs drink the bad water, will they, nill they, because of their great thirst. At the end of those eight days you arrive at a a province which is called Tonocain."

Here we again follow the old caravan route to Tun, and no modern description can add to what Marco says. I would mention that there is a village at Naiband, two marches from Cobinan, but this was founded and the *kanat* was dug only some two centuries ago, as an outpost against the Baluchi raiders who were such a scourge in South-East Persia, never sparing man, woman, or child, but killing without distinction of age or sex. The same remark applies to the village of Duhuk, which has a fort of identically the same appearance, and where the inhabitants give the same account of themselves.

We can now leave the traveller at the town of Tun in the district of Tunocain or Tun and Kain, where he, no doubt, enjoyed a well-earned rest, after successfully accomplishing the difficult and dangerous journey across the Dasht-i-Lut.

To resume the thread of our narrative, the next great event in Persia was the invasion of Tamerlane, towards the close of the 14th century.

Less than a hundred years later, the Sefavi dynasty was established, during the period of whose rule, Sistan and Baluchistan were governed by the Kaianian Maliks, a family of chiefs who claimed descent from the ancient royal line of Persia, and whose tombs lie scattered about throughout these districts, some of which I have seen at Jalk and other places. The best of them were built of burnt bricks, about a foot square and rather more than two inches in thickness, the others simply of sun-dried bricks. One of these sepulchres was about 25 feet square, 20 feet high, and surmounted by a dome. At each of the angles were recesses, and in the centre was the tomb built of mud. Sometimes there were tiles, representing grotesque scenes of peacocks eating snakes, and so forth, but everything was of the roughest description, and there was no great uniformity of design. Many of the sepulchres were approached by a lofty antechamber, while the tombs were generally dark, and the musty odours suggested the presence of bats. The illustrations will perhaps complete my explanations.

During the previous year, Mr. Tate, of the Survey Department, came upon some of these tombs close by in the Maskkel date groves, which had two stories. The upper one contained the tomb of the chieftain, while in the lower one were deposited the remains of his dependants. One of these sepulchres was opened, and Mr. Tate reports "that the grave clothes were in good condition, and that the bones were exceedingly large." The local authorities, when asked for information, could only vaguely say that the tombs belonged to the Kaiani Maliks, who were infidels, but upon returning to Kohuk, on the way to Quetta, I found a tile with an inscription, mutilated in places, but with a few lines legible. The gist of these is that Malik Shumsidin, who lived in 1027 of the Hejra, or 1617-18 A.D., is the individual to whose honour the tomb has been raised. I should mention that we found the most easterly of the series at Gidr, which is not very far from Kalat, in British Baluchistan.

Nadir Shah apparently crushed this dynasty in the middle of the last century, and after his death anarchy was again the order of the day in Baluchistan until the most recent date.

In conclusion, I should like to mention that throughout my wanderings I have always been treated with the utmost courtesy by high and low, and I feel sure that nowhere else in the East is a stranger less subject to fanaticism or dislike. Among those who have particularly helped me in attempting to collect together some fragments of the past, I would specially mention H.H. the Farman Farma, one of the most enlightened statesmen in Persia; while H.E. Nasir-ul-mulk, who is now on his way to represent His Majesty the Shah in this country, has always afforded me considerable help in these subjects of which he himself is a profound student.

DISCUSSION.

The CHAIRMAN said all would agree that Captain Sykes had given them a very valuable and interesting paper. He did not propose to enter on any discussion of the routes taken by Alexander the Great or Marco Polo in their journeys, because he regretted to say that was one of the numerous subjects about which he was very ignorant, but he was sure everyone would agree in wishing him to thank Captain Sykes for the information he had given. It was a popular belief that young officers in crack cavalry regiments did not generally spend their leisure time in abstruse historical and archæological researches, but Captain Sykes had shown that a popular belief could be wrong, or, at any rate, that there were exceptions to the rule. He did not mean to convey, however, that Captain Sykes did not join in lighter amusements; quite the contrary. Many present had probably seen ancient Persian books, and had noticed in them pictures of the Persian monarchs playing the old game of chowgan, which was in fact a rudimentary form of polo. That game had now been quite extinct in Persia for many hundred years, though it had lingered in parts of Central Asia. It had been taken hold of by the English and greatly improved, as they had a way of improving most things they took hold of, and the game of polo was now being re-introduced, by the energy of Captain Sykes, into Persia. It was played on the great parade ground of Teheran, which had been kindly placed at their disposal for that purpose by the Shah. This he thought was not the least of the services which Captain Sykes had rendered to the British Legation in Persia, for a man should be able to play as well as work.

The SECRETARY of the SECTION communicated the following from Major-General Sir Frederick Goldsmid, who was unable to attend the meeting:—

"My personal knowledge of Makran has been obtained by an exploration of the coast and its neighbourhood, from Karachi to Gwadar, under escort of a detachment of Sind Horse, in 1861-2; hurried visits to Chahbar, Jashk, and stations in the Persian Gulf, in 1864; a land journey from Teheran to Kerman, Bampur and, through Persian Baluchistan, Chahbar, in 1865-6, touching by steamer at Gwadar; a land journey from Gwadar to Chahbar, with Major Ross, in 1869; a second land journey from Teheran to Gwadar in 1870-1. A later expedition, in 1871-2, took me to the eastern tracts of Persian Baluchistan, on which occasion I landed at Bandar Abbas, and, passing upwards to Sistan and Mashhad, took the high road from that city to Teheran. Every one of these journeys was, as it were, a political mission; with a native servant or two, or under escort. In 1865-6 Major Murdoch Smith was my fellow-traveller to Kerman. Reports were made in every case to the Government authorities, reference to which would, I doubt not, bear upon some sections of Captain Sykes's journeys. But, with the exception of a few hastily put together notes on the Makran exploration, I never attempted the task of identifying the track of Alexander, his admirals, or generals. I have now perused Captain Sykes's paper—about to be read before the Indian Section of the Society of Arts—and, though time does not admit of entering into his theories with any detail, I venture to record my opinion that he has given us a most important, useful, and interesting *resumé* of travel and observations in a region which promises to become the subject of a new lesson-book. The importance of the subject goes without saying: its use is in throwing light upon a country and people more or less in the immediate neighbourhood of British India, and its interest is rather classical and historical than ephemeral. Here and there I might have hazarded a suggestion or contrary theory; but such remarks, however fitted to personal discussion, might savour of unnecessary criticism if committed to writing. In the latter case they stand on record: in the former they might have been blown to the winds."

Sir H. Howorth, K.C.I.E., F.R.S., M.P., said it had been a great pleasure to him to hear this paper, dealing as it did, most clearly, with a subject which had occupied him a good deal. He could not help feeling proud, in the first place, that the man who had explored this district so thoroughly was an Englishman, and he also felt proud that, like himself, he came from the north of England, where they had a rugged race, which possessed some fine qualities, as had been evident that evening. He could not help contrasting the circumstances of the present author to those under which Marco Polo, in his prison at Venice, without any note whatever of his wonderful journeys, and dictating what he remembered to that poor man to whom they owed the records of his travels. What an extraordinary monument of accuracy, skill and knowledge that book was, when they considered the circumstances under which it was written. This district to the south of the great Persian waste was certainly one of the most interesting in the whole world. 1242 was the date of this particular tomb referred to as the Kubeh-i-subs, and it was the date when the Mongols swept over Persia and destroyed every one in it, except in the particular district of Kerman and the province to the east of it, which escaped by a miracle. It was extraordinary that a building should have been put up of this character in the very year when they destroyed the Caliph and made him drink a great draught of gold, an incident which had been incorporated in so many nursery stories, but which was literally true. That same year the Mongols came into Europe, and the Pope issued a special bull permitting everybody in England and France to eat meat in Lent, because the Tartars, as they were called by the Italians, had created such a panic all over Europe that the fishermen had been afraid to go out and catch herrings and cod in the North Sea, and consequently there was no fish. That was the very year in which the building was erected, of which they had seen the photograph. The Mongols were a very curious people, about whom he had written a book in four large volumes. But there were some things which interested him even more than the Mongols. To go back to the very verge of human history, at the beginning of all things, we had in the valley of the Euphrates the earliest history we knew. There was a struggle there between the inhabitants of the valley and the Elamites. The Elamites, who lived in the mountains to the east and south-east of Mesopotamia, were described as a black race. They were represented on a famous frieze, which was now to be seen in the Louvre—the greatest addition which had been made to the collection for many years—a magnificent frieze of black archers found by Dieulafoi in his excavations at Susa. He had no doubt that the black race represented in the frieze was the aboriginal race of the whole of this country, right away to the Indus. He believed that the race which represented them best at this moment was a little broken tribe of Baluchis, who called themselves Brahui, who spoke a peculiar language, and were excessively black. Not only were they interesting as representing the original primitive population of the area, but he believed they were connected with the peoples of Southern India, the Tamil speaking people, whose civilisation preceded that of the Aryans, and who he believed were a continuous race across this great waste of Makran right away to the Persian Gulf. at the period referred to. It seemed to him that amongst some of these very black people whom Captain Sykes had visited, they had specimens of the link that bound those Dravidian races of Southern India, in the first place to the Brahui, and next, to the people represented on the great frieze found at Susa. This was not his opinion only, for many others concurred in it, and it seemed to him it was the great key to the history of that part of Asia. He felt very grateful to Captain Sykes, not only for making this journey, but for describing it so well. He would conclude with an appeal to the Chairman, who was the English representative at Teheran and had enormous power there, to try if he could not obtain permission to excavate at Susa, and other old sites, which it was very desirable should be explored. So far as he could ascertain the key to the very beginning of history was to be found there. The French had already done a certain amount of surface digging, and by further excavations they would get at the earliest records of a race which was civilised long before the Aryan and Semitic races were civilised.

Captain SYKES then referred to the tiles, carpets, and other articles which were exhibited.

Sir GEORGE BIRDWOOD, K.C.I.E., C.S.I., in view of the lateness of the hour, handed in the following note:—"The paper with which Captain Sykes has so kindly favoured us is of special interest, and an important contribution towards the elucidation of the mediæval and ancient itineraries of Persia. With great brevity and simplicity it records the results of laborious researches, conducted with marked ability and the most persevering thoroughness, and no one who has studied the subject intimately will doubt the soundness of the author's conclusion, on the section of Alexander's anabasis discussed by him, that, in marching from the delta of the Indus, westward, the Macedonian conqueror followed the present caravan route through Southern Persia. Alexander's conquest of Persia and the Punjab could only have been undertaken along the routes of a great and thoroughly organised inland trade between Mesopotamia and India; and there is sufficient indirect proof of the existence, from the earliest historical periods, of such routes, both through northern and southern Persia. The daily comparison of the mercantile Jainas with the literary and industrial Hindus of Western India led me many years ago to the conclusion, which I have several times made public for others to follow out more completely than was ever possible for me to do, that the Buddhism of ancient India was but internationalised Hinduism; that is Hinduism denationalised and humanised by the direct commerce which gradually began to grow up between the West and the East from the 6th and 7th centuries, B.C.,* and continued to grow greater and greater down to the 6th and 7th centuries, A.D., when the conquests of the Arabs, followed by the irruptions of the Mongols, broke up this trade of a thousand years' growth, and reduced Asia Minor, and Syria, and Persia, to the anarchy and barbarism under which they still lie, oppressed and desolated. It was on the flood tide of this overland trade that Alexander was carried through Persia, and on into North-Western India. The routes of this trade through Anterior Asia have never been changed in their leading directions, and those in use now are those already in use in Alexander's days, and used by him. Of this, I have always had the strongest *a priori* conviction, which is being always confirmed by modern investigations on the spot, like those carried out with so much ability and enthusiasm by Captain Sykes. We have proof from a series of cuneiform tablets extending over a century that regular commissariat contractors were always associated with the military expeditions of the Assyrian and Babylonian kings; and we know, from the so-called Arrian, that Alexander's expedition to India was accompanied by Phœnician merchants, partly as contractors, and partly as commercial commissioners, deputed to study on the spot the trade products of the remote countries traversed and explored by "striding Alexander." But what has appreciably changed since Alexander's time has been the landscape, as regards its plant physiognomy, and the climate of Southern Persia, and all Anterior Asia. Persia indeed, lies for the most part within the northern solstitial climate, extending from the Sahara far on the West, to Rajputana in the East, and is naturally a desert region. But in ancient times, the forests and the cultivated lands pressed more closely on the barren tracts, while in the latter, the oases were larger and nearer together. It was the ruthless Arabs and Mongols who destroyed these alpine forests and fertile valleys, and degraded Baluchistan and Seistan, and other provinces of Persia, to the devastated wastes of monotonous misery they yet remain. These points have to be remembered in estimating the difficulties of Alexander's great expedition, both in advancing into India, and on the return march to Babylon. I will say nothing in connection with Captain Sykes's identification of Marco Polo's itinerary through Kirman, except that all he says on the subject would have given the most lively pleasure to Sir Henry Yule. We are under the greatest obligation to Captain Sykes for his paper, and to Sir Mortimer Durand for presiding at its reading.

MEETINGS FOR THE ENSUING WEEK.

TUESDAY, JUNE 8...Royal Institution, Albemarle-street, W., 3 p.m. Dr. Ernest H. Starling, "The Heart and its Work." (Lecture III.)

United Service Institution, Whitehall, S.W., 3 p.m. Admiral Colomb, "The Future of the Torpedo."

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Photographic, 12, Hanover-square, W., 8 p.m. Mr. C. J. Fowler, "Photographic Surveys."

THURSDAY, JUNE 10...United Service Institution, Whitehall, S.W., 3 p.m. "The Great Siege of Malta, 1565."

Royal Institution, Albemarle-street, W. 3 p.m. Mr. Churton Collins, "Wordsworth and Coleridge."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, JUNE 11...Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. W. Crookes, "Diamonds."

Astronomical, Burlington-house, 8 p.m.

Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Mr. C. S. Whitehead, "The Effect of Sea-water on Induction Telegraphy." 2. Mr. Thomas H. Blakesley, "A new Definition of Focal Length, and an instrument for its determination." 3. Drs. J. E. Myers and F. Braun, "The Decomposition of Silver Salts under Pressure." 4. Dr. Fleming, "A new way of determining Hysteresis in Straight Strips."

SATURDAY, JUNE 12...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. J. A. Fuller Maitland, "Music in England during the Reign of Queen Victoria." (Lecture IV.)

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* In a similar manner the internationalisation of Judaism prepared the way for Christianity; and as there were Bauddhas living before Gotama Buddha, so there were Chrestians before Christ.

Journal of the Society of Arts.

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FRIDAY, JUNE 11, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS.

The results of the Examinations held at the end of last March are now ready, and in course of issue to the various centres of examination.

The dates for the Examinations in 1898 will be the 21st, 22nd, 23rd, and 24th of March.

CONVERSAZIONE.

The Society's *Conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, 16th June.

The Reception will be held by Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., Chairman, and the Members of the Council of the Society from 9 to 10 p.m.

Promenade Concerts will be given by the Band of the Royal Artillery in the North Court, and by the Red Band in the Architectural Court of the Museum, commencing at 9.15 p.m.

A Vocal and Instrumental Concert will be given at intervals in the Textiles Court from 9.30 p.m. by the Ladies' Euterpean Orchestra, under the direction of the Misses Scott.

A Musical Entertainment will be given by Mr. George Grossmith in the Lecture Theatre, commencing at 10 o'clock.

Light refreshments (tea, coffee, ices, claret cup, &c.) will be supplied at the usual refreshment buffets in the Central Corridor of the Museum.

Each member is entitled to a card for himself, which is not transferable, and a card for a lady. Members desiring additional tickets can obtain them on payment of 5s. each up to the day of the *Conversazione*; on that day the price will be raised to 7s. 6d. It is requested that Members requiring additional tickets will make early application for them. Every application must be accompanied by a remittance.

Further particulars as to the musical and other arrangements will be given in the programmes, which will be distributed on the evening.

The cards of invitation have been issued to members.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The fourth meeting of the Congrès International de l'Enseignement Technique will be held this year in London, commencing on the 15th of June next. The previous meetings of the Congress were—in 1886 at Bordeaux, in 1889 at Paris, and in 1895 at Bordeaux. The meetings will be held at the invitation of the Society of Arts, and of the Worshipful Companies of Mercers, Drapers, Fishmongers, Goldsmiths, Merchant Taylors, Vintners, Clothworkers, Leathersellers, and Carpenters.

The Congress will be opened at 11 o'clock, on the 15th of June, by an address from the President, the Duke of Devonshire, K.G., and from the President of the last Congress, M. le Professeur Léo Saignat. The meetings will be held on Tuesday, Wednesday, Thursday, and Friday, from 11 to 1, and from 2.30 to 5.

The following foreign delegates have been appointed:—Mons. Felix Martel, Inspector-General of Public Instruction, Mons. Jacquemart, Inspector-General of Technical Instruction, by the French Government; Mons. Eugène Rombaut, Inspector-General of Industrial and Professional Education, Professor Oscar Pyfferoen, of the University of Ghent, and Mons. Wauters, Assistant-Inspector of Industrial and Professional Instruction, by the Belgian Government.

The subscription to the Congress, for others than delegates of foreign Governments, members of the Society of Arts, or liverymen of the companies subscribing, will be five shillings. This will entitle them to a copy of the report of the proceedings.

Applications for persons desiring to become members of the Congress can now be received, and should be accompanied by the amount of the subscription. In return for this a ticket will be sent entitling the members to all the privileges of the Congress.

Members of the Society of Arts and liverymen of the companies will be admitted to the meetings of the Congress on signing their names at the door.

The subjects for discussion at the Congress will include :—

Industrial Education :—

1. Advanced Instruction. Polytechnics, Universities, Colleges.
2. Secondary Instruction. Higher Technical Schools ; Secondary and Intermediate Schools ; Evening Schools.

Commercial Education :—

1. Advanced Instruction. Colleges ; High Schools and Institutes of Commerce.
2. Secondary Instruction. Commercial Schools ; High Schools ; Classes for Adults.

The papers will be printed and distributed at the meetings. The reader of each paper will be allowed twenty minutes to state the substance of the paper. Other speakers will be restricted to ten minutes.

The proceedings of the Congress will be reported in English. Papers intended for the Congress may be in French, German, or English, and speakers may make use of any of these languages.

The Right Hon. the Lord Mayor of London has kindly expressed his intention of inviting members of the Congress to an evening reception at the Mansion-house, on the 17th of June. The Society of Arts annual *Conversazione* will be held on Wednesday, the 16th of June, and members of the Congress will receive an invitation to it. On Saturday, the 19th of June, it is proposed to organise an excursion for foreign delegates.

Arrangements are being made to afford delegates and members an opportunity of visiting the polytechnics and other educational institutions of London.

The following is the order of proceedings. It is subject to alteration :—

The meetings will commence each day at 11 a.m. There will be an interval of an hour-and-a-half from 1 p.m. to 2.30 p.m.

The meetings of Section A will be in the Society of Arts Room ; those of Section B in the Meeting-room of the London School of Economics, 10, Adelphi-terrace, W.C.

TUESDAY, 15TH JUNE, 11 A.M.

Addresses by M. LÉO SAIGNAT and by the DUKE OF DEVONSHIRE, K.G.

Election of Chairmen and Sectional Officers.

Prof. Dr. OTTO N. WITT (Berlin), "Relations of the Teaching of Pure Chemistry and of Applied Chemistry."

Dr. H. E. ARMSTRONG, F.R.S., "Chemical Education in its Bearing upon Practical Industries.'

Prof. LUNGE, Ph.D. (Zurich), "On the Teaching of Chemistry."

J. H. GLADSTONE, Ph.D., D.Sc., F.R.S. "Teaching of Chemistry in Evening Continuation Schools."

WEDNESDAY, 16TH JUNE, 11 A.M.

A

Sir PHILIP MAGNUS, "Theory and Practice in Trade Teaching."

SIDNEY H. WELLS, "Training of Technica Teachers."

Prof. AYRTON, F.R.S.

HERR VON DIEFENBACH, "Technical Education in Würtemburg."

Prof. J. WERTHEIMER, B.Sc., B.A., "Influence of various Examining Bodies on the Progress o Technical and Commercial Education in England."

Sir JOSHUA FITCH, LL.D., "Some Limitation to Technical Instruction."

Sir H. TRUEMAN WOOD, M.A., "The Society o Arts' Examinations."

EDWIN O. SACHS, "A German Technical Colleg from an English point of view."

Prof. OSCAR PYFFEROEN, "L'Enseignement professionel et l'Initiative privée en Belgique."

EDOUARD SÈVE, "L'Enseignement technique e commercial en Belgique."

T. R. ABLETT, "Teaching of Drawing in School in connection with Technical and Commercia Education."

B

F. J. LLOYD, "Technical Education in Agriculture."

HAROLD MOORE, "Practical Training Farms fo Agriculture."

R. W. BAXTER, "Technical Education in relatio to Lithography and Engraving."

W. BOUTALL, "Technical Education in connectio with Process Engraving and Allied Industries."

W. R. LETHABY, "Technical Education in Arch tecture and the Building Trades."

W. AUGUSTUS STEWARD, "Technical Educatio in connection with the Gold and Silver Trades."

THOS. D. WRIGHT, "Influence of Technic Education on the Watch and Clockmaking Industry

H. J. POWELL, "Technical Education in relatio to the Manufacture of Glass."

THURSDAY, 17TH JUNE, 11 A.M.

A

Prof. WILLIAM GARNETT, "Work of the Lond Polytechnics."

QUINTIN HOGG, "Polytechnics."

Prof. SILVANUS P. THOMPSON, F.R.S., "Refor in the Organisation of Technical Education."

GILBERT R. REDGRAVE, "Intervention of t State in Secondary Technical Education."

H. MACAN, M.A., "Development of Technic Education in Secondary Schools under the provisio of the Technical Instruction Acts, 1889 and 1891, and the Local Taxation Act, 1890."

W. VIBART DIXON, "Better Organisation of Examinations as Qualifying Tests, more especially in reference to the qualifications of Teachers of Technical Subjects."

THOMAS TURNER, "Limitations of the Work of County Councils."

A. W. KING, "Some Evening School Difficulties."

WILLIAM SLINGO, "True Basis of Technical Education."

B

JACQUES SIEGFRIED (Paris), "Rapport sur l'Enseignement commercial supérieur en France."

H. W. EVE, M.A., "Suggestions on Commercial Education."

Dr. R. WORMELL, M.A., "Commercial Education and the need of a School of Commerce."

T. A. ORGAN, B.A., "The 'Why and What' of Commercial Education in England."

SWIRE SMITH, "Evening Schools."

SIDNEY WEBB, "Provision of Higher Commercial Education."

L. SUTTLE, M.A., "L'Enseignement des Langues vivantes."

W. A. S. HEWINS, M.A., "Teaching of Economics."

BERNARD DE BEAR, "Commercial Education in England and America."

EDWARD E. WHITFIELD, "Present State, Claims, and Prospects of Commercial Education."

STANLEY LATHAM, "Book-keeping."

FRIDAY, 18TH JUNE, 11 A.M.

A

COUNTESS OF WARWICK, "Technical Education in Rural Districts."

Miss ALICE MITCHELL, B.Sc., "Teaching of Domestic Economy in Girls' Secondary Schools."

Miss FANNY L. CALDER, "Secondary Education in Domestic Science."

Miss PYCROFT, "History of Training Schools for Teachers of Domestic Economy in England."

Miss L. EDNA WALTER, B.Sc., "Treatment of Domestic Science as an element in Girls' Education."

Miss E. P. HUGHES, "Relation between Technical nd General Education, with special reference to the Technical Education of Girls and Women."

B

JERVOISE A. BAINES, C.S.I., and M. M. BHOWNAGGREE, M.P., C.I.E., "Technical Education in India: its Conditions and Prospects." Part I. General Conditions. Part II. Present ondition and Prospects.)

Dr. PETERSON, "Technical Education in Canada."

Dr. MACKAY, B.A., B.Sc., F.R.S., "Technical ducation in Nova Scotia."

Sir WM. C. WINDEYER, M.A., LL.D., "Technical ducation in New South Wales."

H. F. EATON, "Technical Education in Victoria."

D. T. LYONS, "Technical Education in Queensland."

J. R. TRANTHIM FRYER, "Growth of Technical Education in Tasmania."

Dr. PHILIP COX, "Technical Education in New Brunswick."

Concluding Meeting 2.30 p.m.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, April 27, 1897; JOHN SPARKES, R.I., in the chair.

The paper read was on—

DELFT-WARE.

BY J. W. L. GLAISHER, SC.D., F.R.S.

Delft-ware takes its name from the little town of Delft in Holland, which well deserves the title of "Parent of Pottery" that has been applied to it. For nearly 250 years the fabrication was continued, and at one time as many as thirty factories were in operation.

During all this long period no other special manufacture was carried on, and we have the singular spectacle of an isolated town taking up an entirely new industry, raising it to its highest perfection, and maintaining its unique position against all rivalry up to the very last, when the time had come for enamelled earthenware to give place to stoneware and porcelain.

It is true that the potters of Delft formed themselves into a guild and took all the steps which were then available for retaining in the same spot a trade that had once become domiciled there, crushing out as they arose the various factories that were started from time to time in other Dutch towns. But these methods were necessarily powerless against foreign competition, and the long pre-eminence of Delft must be attributed to the superiority of its productions, assisted no doubt by the commercial activity and maritime enterprise of Holland. There are of course natural ceramic centres like Staffordshire, where pottery of some kind has always been produced, and numerous towns can be mentioned, such as Rouen and Nevers, in France, and Bristol, in England, which have become celebrated for the fabrication of wares of the same class as those made at Delft, but in no other case does the fame of a town rest solely upon a single kind of earthenware, manufactured there with but little variation during a period extending over centuries.

It has been shown by M. Havard,* that before the closing years of the sixteenth century no pottery or faïence was made at Delft. In the fifteenth and sixteenth century the town was celebrated for its breweries and for the manufacture of cloth. The latter is, perhaps, the older of these two industries, for it certainly goes back to 1413, but the brewing was an important part of the trade of the town as early as 1450. The Delft beer acquired a considerable reputation, and there was a time when nearly 300 little breweries bordered its canals, and exported their products to all parts of Holland. In 1536 a terrible fire destroyed almost the whole of the town. In consequence of this catastrophe, the Emperor, Charles V., exempted the citizens from direct taxation and the Delft beer from excise duty for a term of twenty years. About 1573 the Stadtholder, William the Silent, took up his residence in Delft, and it was there, in the Prinsenhof, facing the old church, that he was assassinated on July 10th, 1584. The presence of the Stadtholder's court at Delft, had rendered the town to some extent an artistic centre, and the higher arts of the goldsmith, the tapestry-maker, and the wood-carver or cabinet-maker were called into existence. William's son, Maurice, was elected Stadtholder in his place, but he never resided in Delft, so that after a brief period of political and social prosperity the town was left in 1584 to fall back upon its industries alone. At this time the manufacture of cloth seems to have died out, and the breweries were beginning to decline, but, within a few years, Herman Pieterz was destined to introduce the beautiful art which was to give to the town its real celebrity.

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* "Histoire de la Faïence de Delft." Paris, 1878.

The evidence which has led M. Havard to assign to the years between 1596 and 1611 the date of the introduction of the manfacture of faïence into Delft seems to be quite conclusive. He finds that all the official documents relating to the town are in perfect accord in this respect. Those of an earlier date than the seventeenth century are absolutely silent on the subject of pottery: one indeed, of 1596, is of exceptional interest, as it gives a list of all the trades permitted to be carried on in the town, and in this list the potters are not mentioned. In the book containing the decrees of the Magistrate the first mention of pottery occurs in the Act constituting the Guild of St. Luke in 1611. The "Masters' Book" of the Guild begins with 1613, and at that time there were inscribed the names of eight master potters, the first of which is Herman Pieterz.

M. Havard has divided the history of the fabrication of the ware made at Delft into three periods. The first period, 1596-1650, is characterised by an extremely full decoration, generally executed in blue, the subjects represented being principally battles, historical scenes, &c., frequently containing great numbers of figures. Pieces of this period are very scarce, even in the large museums, but a fair number of specimens are to be seen in the Rijks Museum at Amsterdam.

The second period, which we may take to be 1650-1710, is chiefly remarkable for the wonderful imitations of oriental porcelain, not only in blue, but also in red, green, yellow, and gold. The so-called cachemire decoration and the superb work of Pynacker, Fictoor, and Van Eenhorn, who applied polychrome decoration to a black ground, belongs to this period. The blue and white ware also underwent development and improvement. The painting often displays great talent; most of the subjects represented are Chinese in character, but there are also many charming landscapes and rural scenes.

The third period, extending from about 1710 to the end of the fabrication, was entirely commercial. Every kind of useful and ornamental article was manufactured in immense numbers and transported to all parts of the world. The quality of the work was of every degree of excellence and badness, and the decoration in every variety of style.*

The fine and hard wares of Staffordshire became serious rivals to the softer and less durable faïence, and the struggle for existence was being keenly felt, even as early as 1760, among the Delft factories. Of the thirty which existed in the town at the beginning of the century but ten survived till 1794, all in a more or less languishing condition. The manufacture, however, still lingered on until 1850, when the last factory was closed.

In order to appreciate properly the qualities of any piece of pottery, some knowledge of its technique is required, and this is especially the case where, as in delft-ware, the painting takes place upon a crude surface. It will therefore be convenient at this point to give a brief account of the process of manufacture.

The clay was thrown or moulded in the ordinary way and submitted to a first firing. The article was then dipped in a white liquid, the dense matter in which formed a white coating to the body of the earthenware. The painting was effected on this white porous substance. The article was then covered with a transparent glaze and fired again. In the second firing the white coating and the glaze were both fused, the former becoming a white enamel, generally of a milky hue, and the latter a thin layer of glass.

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* The amount and extent of the exportation by sea in the last century is shown by the fact that in England and the United States, delf was the general name for all kinds of plain domestic earthenware as distinguished from fine wares or china. The word is still used in this sense.

Both firings took place in the same kiln, but a higher temperature was required in the second firing to fuse the enamel. The articles in their raw state were placed for their first firing at the top of the kiln where the heat was less.

Leaving for the moment the exact constitution of the white liquid, it is sufficient to say that the opaque white matter held in solution consists of oxide of tin mixed with oxide of lead, and other substances, which became fused in the second firing. The clay, in its biscuit state, after the first firing, is very absorbent, and when dipped into the liquid rapidly drinks in, so to speak, the water, leaving behind upon the surface a white coating of solid matter. In order to paint upon this spongy substance, which may be compared to blotting paper, very great dexterity as well as suppleness of the hand is required, which can only be acquired by early training and long practice. The difficulty is increased by the nature of the paints, which are formed of a mixture of the colouring matter, itself very fluid, with pure water without the addition of gum or any other substance to give cohesion.

On account of the excessive "thirstiness" of the ground and the very liquid character of the pigments, the artist has to manipulate his brush with great skill and quickness, for the least delay or hesitation on any spot causes too much of the colour to be absorbed there, and spoils the piece. The sharpness of the contours depends upon the limpidity of the colours and the rapidity of execution. Very rapid work is also required for shadows, as otherwise, however limpid the paint, they become thick and dark. The moment the artist takes the brush in his hand he has to decide upon the exact amount of intensity to give to the contours and shadows, as no subsequent rectification or alteration of the work is possible. It is clear that painting executed upon so uncongenial a substance cannot be very accurate, or exact in detail, but the boldness and vigour imposed by the conditions give to the finished work a special character and charm which is quite its own. Patience and care were not the qualities required in the artist, but there was ample scope for the display of originality and dexterity, and in spite of the difficulty of working upon a spongy and absorbent surface effects could be produced of the most surprising delicacy.

For my own part, I cannot bring myself to feel any satisfaction in painting executed upon the glaze. The surface is hard and there is no intimate connection between the painting and the manufactured ware to which it is attached. The colours are fired at a much lower temperature than that required to produce the piece, in fact only just so much heat is applied as will make them to adhere to the glaze. Such an addition to the surface of pottery or porcelain is no real part of the object. It is frequently even worse than an unsuitable excrescence, as it may effectually conceal the whole of the ware itself so that its substance might just as well have been plaster or metal. In the case of delft, the colours are part of the actual ware itself, incorporating with the enamel and modified and brightened by their contact with the glaze through which they are seen. The body, enamel, colours, and glaze, are all fired together at the same high temperature and form a single work of art, complete in itself, unproducible by any other method, defiant of the attacks of time.

Although the wonderful pieces of the middle period, in which the ground is sometimes black, or green, or yellow, and where gold has been freely applied to heighten the effect, are very interesting and beautiful, and extremely precious on account of their great rarity, it seems to me that the real charm and beauty of the ware is to be seen in its highest perfection in some of the pieces decorated only in blue upon a white ground. The blue combines with the enamel, entering into it and blending with it, and if the firing has been successful, the colour is pure and bright without undue brilliance or self-assertion. In the best specimens, where the painting has been executed by a master's hand, and all the circumstances of the firing have been favourable, there is a softness in the blue, melting into the white of the enamel—or rather, so to speak, absorbed in it—and seeming to lie deep down beneath the glaze, which gives a peculiarly charming effect, not only to the decoration but to the piece as a whole. However beautiful the polychrome work may be, it seems to me that the best pieces of "coloured delft" are not comparable to those which are decorated only in blue. None of the other colours assimilate themselves so well with the ground; the reds and red-browns often seem to lie upon the surface of the enamel without entering into it at all, and even the yellows are very rarely quite satisfactory.

In these remarks, I am referring only to really good productions which show the capabilities of the ware. The decoration of the ordinary run of moderately good pieces is effective and often striking when seen from a distance, but they will not bear a closer inspection: indeed, when a piece is looked into, it is sometimes difficult to understand how the rough outlines and patches of colour can form so good a design and show off so well. The collector, however, occasionally meets with specimens which lose none of their charm when carefully examined; the general effect of the painting, of course, is lost, but the softness and beauty of the colour and enamel are even more delightful.

As has been already stated, the date of the origin of the manufacture at Delft of earthenware covered with a stanniferous enamel can be established to within a few years, for before 1596 there was no factory in existence, and by 1613 there were eight master potters. It seems to be certain that Delft has no previous ceramic history, and that the making of faïence there was not a development of an earlier industry, but was introduced as a new and complete art.

In the case of Rouen, which it is natural to refer to now as being, next to Delft, the most considerable seat of the manufacture of stanniferous faïence, it is known that tiles were made there by Abaquesne in the middle of the sixteenth century. Then comes a gap of nearly a hundred years, till 1647, when there is evidence that faïence was again being made. The date of the commencement of the fabrication on an extensive scale may be taken to be 1673, when letters patent were granted to Louis Poterat for the establishment of a factory of "faïence and porcelain" at Rouen. In 1722 there were eleven important factories, employing 2,000 workmen, and as late as 1783 there were eighteen master faïence-makers. Towards the close of the century the manufacture languished and declined owing to the same causes which produced the decadence of the Delft factories.

Next to Rouen in amount of production must be placed Nevers. The manufacture of faïence in this town began earlier than in Rouen, and covers a much longer period of time, extending from 1608 to well into the present century.

It cannot be doubted that the manufacture of earthenware coated with a stanniferous enamel was introduced into Holland and France from Italy, for the material itself and the mode of manufacture do not differ essentially from the majolica, generally associated with the name of Luca della Robbia, which had been made in varions Italian towns for the previous two centuries. We know that the founders of the industry at Nevers came from Italy, and we should expect that it would have been the same at Delft, but Herman Pieterz was born at Haarlem, and we find no Italian names among the early Delft potters. This is very remarkable, as the processes of manufacture at Delft show a closer connection with those which had been employed in Italy than is the case with French faïence. It would seem, therefore, that the art must have travelled from Italy to Delft by the way of some other Dutch town. In the letters patent of Louis Poterat, it is stated that he has found the secret of making "la véritable porcelaine de la Chine et celuy de la fayence d'Holande." Thus the first important factory at Rouen was founded for the manufacture of the kind of wares which were then associated with Delft. The date is so late that of course we should not expect direct relations with Italy. It is known that some of the workmen came from Nevers, and their influence is seen in the earliest pieces.

Rouen is associated with several very well-marked styles of decoration, some of which were perhaps derived from tapestry, lace, ironwork, &c. The name suggests at once the radiating designs—the decorations "à lambrequins" and "à broderies,"—the cornucopia design ("à la corne"), and a few others. There are also certain special styles associated with Nevers. But in the case of Delft, it is not easy to think of any classes of decoration which can be selected as characteristic of the fabrication in the same sense; of course, there are many common designs which were reproduced over and over again, just as the willow pattern has been repeated on stonewares in this country, and which at a glance tell the origin of the piece, but they cannot be said to have enough character to be actually distinctive. It is really for the immense variety of its designs that Delft was so remarkable; there seems to have been no kind of decoration either upon oriental or European porcelain, or any other class of ware that was not copied and developed.

Many rustic scenes and landscapes are obviously Dutch in style, but they do not bear a sufficiently large proportion to the whole to be regarded as representative of the production of the town.*

Just as Nevers is celebrated for its early pieces in white on a beautiful "bleu de Perse" ground, so may the pieces by Pynacker, &c., be counted as one of the chief glories of Delft.

If the ware itself, as well as the decoration, be taken into account, I think that the imitations of Chinese porcelain are perhaps the most characteristic products of the town. It seems strange that it should be possible to regard a copy of another material as characteristic, and yet none of the rivals of Delft produced in any quantity a ware so curious or admirable. The imitation is often so good that even a practised eye would be deceived at a little distance as to the origin of the piece, but when examined closely the enamelled earthenware has a certain softness which is particularly attractive. The first period of the fabrication seems to be distinguished by the absence of Chinese designs, but afterwards when oriental china was imported into Europe on a large scale, the great mass of the decoration of the Delft pieces shows a Chinese motive. The general tendency of the times to copy oriental designs may have been increased by the fact that much of the trade with China was carried on by the Dutch East India Company, one of whose depôts was at Delft.

It is not impossible that some of the pieces made at Delft were meant to be forgeries, but it is sufficient to suppose that the wider knowledge of oriental porcelain had inspired an interest in the ware, which led to a demand for pieces of a similar appearance. The skill with which the enamel and glaze were manipulated so as to resemble porcelain so closely, both as regards general appearance and the "shine" of the surface in various lights, is truly remarkable, but it is in the ware itself, independently of the accuracy of the reproduction, that I find the fascination. For myself, I prefer the specimens in which there is little or no Chinese motive, and even if quite undecorated, some pieces would be very attractive solely on account of the charm of the material.

Vast numbers of tiles were made at Delft and, as in the case of the other wares, they were of every degree of merit. In most of them the decoration is in blue, but it is often in violet-brown; polychrome tiles are much less common. As a rule the painting is rough, and in many cases, where the subject is religious, the treatment is somewhat grotesque; but occasionally sets of tiles are met with in which the painting is as good as on the best plates. The large plaques made of tiles are characteristic and date from a very early period of the fabrication. A great many of these plaques are exhibited in the Amsterdam Museum, but it is not easy to see good specimens elsewhere. Solid plaques (in one piece) representing landscapes, birds in cages, dogs, &c., were also produced in considerable quantities; this kind of plaque was also made at Rouen and other places.

When we consider shapes, there are several kinds of vases which instantly suggest Delft as distinguished from Rouen or other centres of production. I do not suppose that any of the shapes could have originated at Delft, but such enormous numbers of these vases were made that they are now to be seen in nearly every bric-a-brac shop of Western Europe. The forms most usually met with are either circular, or somewhat flattened (frequently octagonal in reality), decorated with a scene in front, but with merely a rough ornament in the back and sides. These latter vases may fairly be regarded as representative of the town, although the majority of them do it little credit. I think it would be found that most of the shapes attributed to Rouen by French writers had been previously made at Delft, for I have several times obtained early Delft pieces the shapes of which would be classed as "Rouen." The sets of five vases (garnitures) for the decoration of chimney pieces, &c., were made in great numbers; some of them, dating from the early part of the last century, are very beautiful and striking.* Great quantities of curiously shaped pieces (dishes in the form of birds, vegetables, &c.) were produced. The larger objects of this class, although interesting ceramically, are not very attractive,† but many of the smaller modelled pieces (cows, &c.) are excellent. I do not think that the very large modelled pieces (such as dogs, &c.,) intended for use in halls and out of doors, and for which Rouen is celebrated, were made to any great extent at Delft.

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* Among designs that have specially interested me, I may mention "Dragons" and "Tea-plants." The former consists of a four-footed dragon upon a background of leaves, flowers, and twigs, surrounded, in the case of plates and bowls, by a border consisting of a diaper pattern alternating with white concave spaces containing a conventional design which is always the same. It is curious to notice the persistence with which the accessories of the design are repeated. Thus, in plates and bowls, the dragon and leaf-ground are surrounded by a white space bounded by two concentric circles and quite destitute of decoration. Then comes the diaper border and a red-brown edge, when the decoration is in blue. In nearly every instance all these details occur without variation. The artists also have allowed themselves very little latitude even in the painting of the dragon. The "Tea-Plant," (so called by the Dutch dealers) represents a bushy spreading tree having a curious scar on the trunk: the branches are divided into three tufts above the central portion, which contains two flowers resembling eyes. In this design, which is pretty and effective, there is much less uniformity and it is interesting to examine the variations in a collection of specimens. Both designs are obviously oriental, but I have never succeeded in seeing an oriental piece which has a real resemblance to either. It has often been remarked that Delft plates, unlike their oriental originals, were very seldom decorated on the back. When there is any attempt at decoration it generally consists merely of a few concentric circles, or of o's and crosses placed alternately at wide distances on the part of the plate outside of the flange. The best known Delft pattern, and one of the most striking, represents a vase containing flowers, with a radiating feathery back-ground, the whole design giving the effect of an expanded peacock's tail. Many other patterns, besides those derived from oriental porcelain, "Water and Ducks," "the Hart," &c., will at once occur to any collector, but he variety of the designs is so enormous that I think that no matter how many a collector may have seen he is always liable to be surprised by curious novelties.

No one who is fond of the faïence of Delft can help regretting that the factories struggled on so long. A great deal that was produced after the decadence had well set in, is so poor and commonplace as almost to justify even a connoisseur in taking a dislike to the whole ware. The colours are harsh and aggressive, the painting itself is bad, and sometimes the enamel is coarse, so that it seems incredible that the same process could ever have produced fine ware. It is not uncommon to see pieces belonging to this last period in which the enamel is fairly pure and good, though the painting is horrible.* Up to the very last some of the blue pieces seem to have been pretty good, but I do not think it likely that any good polychrome work was produced during the later years of the decadence.

Nevers resembled Delft in having a long period of decadence, but the French revolution supplied the motive of the decoration, so that the "faïences patriotiques" of Nevers, though not in any way superior as works of art to the contemporary wares of Delft, possess a peculiar historic interest which will always render them valuable.†

I now come to the distinguishing point between the wares of Delft and the French stanniferous faïence. This consists in the fact that the former was covered by a transparent glaze which is absent in the latter. At first sight it would seem difficult to understand how the glazing was effected without a third firing, as the dipping the painted enamel into a liquid glaze would cause the colours to run. The method is described by Gerrit Paape in his work of 1794, which has been reproduced in French by M. Havard. The workman dips a short rough-haired brush into the liquid and shakes it violently to get rid of the excess. He then sprinkles the object to be glazed, which he holds in his hand, until it is as white as snow. This process, according to M. Deck, was not followed by the French makers of faïence. The glaze not only has the effect of heightening the colours, but it also protects them from evaporation, and indeed, to me it seems that it is just this glaze that gives to the best wares of Delft their superiority over those of Rouen and Nevers. The difference in effect is not very noticeable at a distance, especially if the design be large, but it becomes very evident when a closer inspection is made. Without the glaze it would have been impossible for the Delft potters to produce their wonderful imitations of Chinese porcelain, and to any one who has become accustomed to the brightness of the best Delft pieces, the dull and faded appearance of much of the most admired French faïence is very disappointing. How this essential difference between the French and Dutch processes could have arisen, and why it should have always continued, is difficult to conjecture. It is known that the Italian majolica was covered by a glaze of somewhat similar composition to that used at Delft, and it is almost impossible to resist the conviction that the process must have passed from Italy to Holland. So far as I can see, the glazing process was carried out in the English delft factories, and we should expect this to be the case also in other countries where the manufacture was introduced from Holland.

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* In many of the vases, the moulding of the lions, dogs, &c., which form the tops of the covers is very bad. I have seen "garnitures," in which the painting on the sides of the vases was excellent, entirely spoilt by the clumsy modelling of the tops, which look as if they had been half melted in the firing; the blue, too, has often lost its brilliancy, and become dark and heavy. This is curious, as some of the separately modelled pieces of the same size are so admirable.

† One reason why these larger pieces, which are generally decorated in polychrome, are so unsatisfactory, is that the reds are dull and bad in colour. It seems as if the glaze, which covers the blues and greens with a thin layer of glass, entered into combination with the reds, when spread over a considerable area, giving them the appearance of having been painted afterwards and not fired at all. The yellows are sometimes bright and entirely covered by the glaze, but sometimes they share the fate of the reds. When red is sparingly used on a white ground, as in pieces by Pynacker, it shows well, but in large objects, all covered with colour (as for example in a vegetable-dish shaped like a cock) the extensive areas of dull brownish-red and yellow deprive the piece of the very qualities for which the ware deserves to be admired.

* In many of the plates made at the "Claw" and having the design, already referred to in a note, of the "expanded peacock's tail," the enamel is very milky and attractive, and the painting quite satisfactory. These plates are so numerous that it would seem that this must have been the principal design in use at the Claw and Blompot in their last days.

† The only corresponding products of Delft are the plates representing Prince William V. and the Princess Sophia Wilhelmina, generally separated by an orange tree. These plates must have been made in enormous quantities, judging by the number that are now to be met with. The "patriotic" designs were also painted on English stone ware, and exported into Holland.

It is probable that Delft not only trained the best painters and workmen, but that it always retained their services; and it is, I think, unquestionable that the finest pieces of delftware (*i.e.*, earthenware covered with a tin enamel and a lead glaze) that have ever been produced were made there. The general superiority of the wares of Delft over those manufactured elsewhere, even by Dutch workmen, must, however, be attributed to the excellence of the mixtures of clays adopted there, which gave to the body of the ware just the right porosity to deposit the proper thickness of enamel, and produced a contraction during firing that was in perfect sympathy with the enamel, so that there were no cracks or other signs of crasing.

Gerrit Paape states that the clay employed at Delft was obtained by the mixture of three different clays, viz., the Tournai clay, the Rhine clay, and the Delft clay, combined in the proportions of six, three, and two. He mentions that the Tournai clay was often replaced by that of Brabant, and that the Rhine clay came from the neighbourhood of Leyden, and even of Delft itself.*

M. Deck, referring to French factories (Rouen, Nevers, Moustiers) remarks that the composition of the enamel was the same, and that the great differences in the appearance of the pieces are due solely to the quality and properties of the local clays. I think we may assume that this is substantially true generally, the great variations in the quality of the products of the different towns being attributable almost wholly to the nature of the clays, so that the composition of the enamel (except as regards tint or colour) need not be taken into account. The body of the ware made at Delft was buff-coloured after firing, and is very light in weight. The pinkish appearance seen under the enamel in so many English pieces is, as is well known, due to the less absorbent quality of the English body, the reddish hue of which shows through. Pieces made in the North of France (Desvres, &c.) or at Brussels or Bruges are often as well painted as those of Delft, their inferior quality being obviously due merely to the hard and coarse body, too thinly covered by the enamel. I have frequently met with plates in France, possibly made at the minor factories, which, though elaborately and excellently painted in polychrome, were quite spoilt by their dull and blistered appearance. At first sight it would be natural to regard these as good pieces which had gone wrong in the firing, but they are too numerous to be so explained, and I think that the bad result must be attributed to an unsatisfactory body and the absence of a glaze.*

The ordinary German delft-wares are easily distinguished from those made at Delft. The blue is raw and harsh and the quality is poor. As a rule the softness which characterises the good ware of Delft is quite absent. In the districts near Nuremburg, and probably elsewhere in Bavaria, great numbers of tankards, generally decorated in polychrome, were made, and some of these are comparable to the products of Delft itself, though in most cases the true "shine" is missing. In quite a number of pieces the enamel itself is coloured (green, yellow, or blue). Sprinkled or mottled grounds, such as are in this country associated with Liverpool, are also common in Bavaria.† The Zurich delft is not unlike that made near Nuremburg; but the body of the delft ware of Winterthur is so hard, and the enamel so thin, that it is of quite a distinct character. On the whole I think, that next to the English delft, the products of Zurich and the region around Nuremburg have the closest general resemblance to the ware made at Delft. Most of the contemporary Italian and Spanish faïences, though technically to be classed as a delft-ware, as the enamel is stanniferous, are so different in character, being often dull and with a smeary appearance, that they need not be referred to here. It is curious, however, that some of the best pieces of white delft (scalloped plates and drug pots), both as regards quality and glaze, that I have seen, are (presumably) Italian.

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* It is noticeable that Delft seems to have possessed no special natural advantages for the making of earthenware. The clays used would have been available also for other towns, which probably would have been equally well placed as regards water carriage. The conditions were such, however, that when Delft had gained the trade, it would clearly be difficult for any other town to deprive her of it.

* It is a singular fact that the brightest delft plates that I have ever seen were met with in France. This would seem to suggest that the wares made by Aegestyn Reygens and others for exportation to France were especially brilliant.

† These grounds also occur frequently in Bruges pieces.

The stanniferous enamel was composed of lead, tin, silica, and alkaline substances. The lead and tin were first combined into what may be called the *calcine* as follows:—After the furnace had been lighted four or five hours, the lead and tin were introduced (in bars or ingots) in the proportion of about three to one. The heat of the furnace was gradually raised, and when the metals had become perfectly liquified, a kind of foam was seen to form upon their surface, in which little bright stars flashed out from time to time. The oxygen of the atmosphere was then combining with the metals. The process was continued until the metals were completely oxidised.

A substance called mastic was formed by melting sand, sea-salt, and soda in the proportions of 500, 60, and 30. When fused a fragile body was produced which was finely pounded.

The enamel or "Wit" (white) was then obtained by fusing 50 parts of calcine, 65 of mastic, half a part of smalt, and a small quantity of red copper filings. A very great heat was required to melt this composition, which was therefore placed in the hottest part of the oven. It was then pounded and ground to a great degree of fineness between millstones. This powder, when mixed with a suitable quantity of water, formed the enamel into which the objects were dipped in the biscuit state after their first firing. The smalt was evidently introduced in order to improve the colour.*

The preceding description relates to the process employed at Delft, the proportions being taken from Gerrit Paape. M. Deck states that in France the proportion of lead and tin in the calcine varied between three to one and four to one, and that the enamel consisted of calcine 44 parts, sand 44, sea-salt 8, soda 2, minium 2. These substances were mixed together and fused. He adds that the amounts of calcine and sand were always equal, and that the fluxes alone varied, but within very restricted limits. Taking Gerrit Paape's proportions and reducing them to a common denominator of 100 for comparison with M. Deck's, we find as the composition of the Delft enamel, calcine 43½, sand 47½, sea-salt 6, soda 3. The constitution of the enamel is therefore nearly the same in both cases.

According to Piccolpasso the enamel of the Italian majolica of the sixteenth century consisted of a combination of the calcine, a frit called marzacotto, and sand. In the calcine the proportion of lead to tin varied between two to one and four to one. The marzacotto usually consisted of sand 12 parts, lees of wine 10, salt 3. The calcine, marzacotto, and sand, were fused in various proportions to form the enamel. Thus the marzacotto was of the same nature as the mastic and contained the alkalies, but the proportion of sand was much less. A good deal of sand was therefore added independently, the proportions of calcine, marzacotto, and sand being, in two of the formulæ, 10, 10, 12, and 16, 10, 10. M. Deck states that in no other country but Italy and Holland were the alkalies introduced into the enamel by means of a frit. He considers this method preferable to that employed in France of fusing all the constituents of the enamel together at once, as the materials, being better incorporated, do not produce a saline efflorescence.

The glaze used at Delft (called the "Kwaart") was composed of mastic 36 parts, litharge of gold 42, potash 4, salt 7. These constituents were well mixed and fused, forming a substance of great hardness, which was then ground to an exceedingly fine powder. The litharge of gold is plumbic oxide, with a little minium. Replacing the mastic by its components, we see that the glaze may be regarded as composed of litharge 42, sand 30½, salt 10½, potash 4, soda 2. The Kwaart was therefore by no means a purely lead glaze, but was partly lead and partly alkaline.

Gerrit Paape gives the following two formulæ for the blue:—Zaffre 8, smalt 5, mastic 4; or zaffre 50, sand 25, potash 25. In both cases the composition was fused and ground to powder. A more common kind of blue was made by increasing the proportion of mastic or sand to the zaffre. On the other hand the blue was improved by increasing the proportion of zaffre. The zaffre is a mixture of cobalt and sand; smalt is powdered glass coloured with cobalt.

Similarly for the violet there were two formulæ according as the mastic was used or not, both of which are very simple, viz., "brownstone" 1, mastic 1; or "brownstone" 1, sand 2, potash 2. The "brownstone" was an ore of manganese. The formulæ for the yellow were: antimony 9, litharge of gold 7, calcine 1½, salt 1½; or antimony 10, litharge of gold 6, calcine 2, salt 3. Garrit Paape states that the red was obtained by burning good bole five or six times. The bole was a clay coloured by oxide of iron.

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* The coloured enamels were of course obtained by introducing colouring substances into the constitution of the enamel, and this may have been effected in different ways. There are great varieties in the tint of the white enamel, much of it having a greenish hue. One form of border decoration associated in this country with Bristol, consisted in "painting" with a pure or cream white enamel slip upon a greenish-white ground.

There were no other colours; green was obtained by mixing yellow and blue, and orange by mixing red and yellow.

The fact that both the Italians and the Dutch introduced the alkalies into the enamel by means of a special frit, and that in both countries the ware was covered with a glaze, which was partly plumbic and partly alkaline, affords strong evidence that the Dutch must have derived their method of fabrication directly from the Italians, and it would seem to establish a closer connection in this respect between Italy and Holland than between Italy and any other country.

Now that the "mystery of porcelain" has long since passed away, and that it is certain that hard porcelain will continue to be manufactured for years to come in great, and probably increasing, quantities, it would seem that the relative positions of porcelain and faïence have become inverted since the first half of the last century. Faïence belongs, as an industrial product, to a past stage in the world's history, and it is unlikely that delftwares will ever be made again commercially on an extensive scale for practical use. There may be artistic revivals, but it is clear that for domestic purposes (dinner services, &c.), the fragile and clumsy faïence cannot compete with stone wares and porcelains.* We have seen that in the manufacture of delftware the nature of the surface called into existence a special kind of rapid painting—a distinct art, which was capable of producing unique results of great merit. We may feel pretty sure that if artistic work of a high character is again produced upon a stanniferous enamel under a lead-alkaline glaze, it will be essentially different from the fabrics of the old delft potter.

In the last few years the old delft-ware has been copied in immense profusion, not only the forms and designs, but often the makers' marks being reproduced.* The surface and colours, however, are so dull that no one who has made any study of the subject could be deceived. It seems probable that the difference may be partly due to the fact that in the modern copies some mode of painting on a hardened surface is adopted. Judging by the vast amount of modern "blue and white" delft-ware exhibited in the shops of all the countries in Europe, the amount placed upon the market must have been enormous.

It is singular that there should be, apparently, so great a sale for these modern goods, which are high-priced and wanting in the very qualities which gave to the old delft its chief attractiveness; and it is also curious that the new wares should not cause greater attention to be paid to the old, but, so far as I can see, the flooding the shops with the reproductions and forgeries seems to have made no difference to the collector; of course prices have risen, but this is probably merely as a consequence of the generally increased interest which is being taken in all kinds of antique works of arts.

At the old factory of "The Porcelain Bottle" at Delft, an excellent and interesting ware is now made by MM. Thooft and Labouchere, but it is quite different in character from the ancient products of the town, the body being white and hard. This factory has never ceased to exist, though for a time, after the extinction of the old trade of the town, M. Thooft used it merely for the manufacture of firebricks, &c.

It is greatly to be regretted that delft-ware should be so poorly represented in ceramic collections. In the Continental museums Holland has almost as much ground for complaint as England with respect to the kind of specimens exhibited. There are small but interesting collections of Dutch delft at the Cluny Museum in Paris, at Sévres, and a few other places, and valuable local collections are to be found in the museums of Nuremberg, Boulogne, and very many other towns. But as a rule the specimens of Dutch delft exhibited consist of pieces of the commonest order, which give an unjust and misleading idea of the character of the ware. The only representative collection which I know is that contained in the Rijks Museum at Amsterdam. Next in order of value I should be inclined to place the collection at South Kensington, as though the pieces are few in number they are as a rule beautiful of their kind and well display the merits of the ware. Moreover, they are of the class which a collector has but little chance of obtaining for himself, except on the dispersal of one of the great private collections.

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* The fragile nature of delft-ware is well illustrated by the great scarcity of articles intended for domestic use excepting only plates and punch-bowls. I have in my collection but one wash-hand basin and one teapot. Tea cups are excessively rare although they must have been made in great numbers. It is curious, however, to note that delft-ware jugs are still made in France for ordinary domestic use. Last year at a crockery shop in Caen I bought a small white jug (not unlike Lambeth delft) which was stamped with the name of its factory, Lunéville, and I have bought at similar shops in Dieppe and Rouen, modern delft jugs (possibly also made at Lunéville), with a white decoration upon a blue enamel, exactly similar to the jugs occasionally met with in England and believed to have been made in Staffordshire during the last century, in imitation of the blue ware of Nevers.

* Some of the modern so-called "delft" is very far from being a reproduction of the old ware; the shape and perhaps general style of design are followed, but the treatment is different, and the pieces bear the mark of their (modern) factory. In many cases, however, the old pieces are exactly copied, and also the mark of an old Delft potter or factory or both, without the addition of any modern mark. These objects are constantly labelled in shops "fine old delft" and presumably they were intended to be sold as such. It should be mentioned that the coloured ware of Rouen has also been reproduced very successfully in great quantities; and reference should be made to the faïence produced at Quimper, which is properly marked, and may be regarded rather as a development than as a reproduction of the old wares of the town.

Everyone who is interested in delft-ware, must feel himself under the deepest obligation to M. Havard for his splendid work, which has made it possible, for the first time, to study the subject with the help of accurate historical knowledge. Not only has M. Havard searched all the known documents relating to the town and the guild, but he has minutely examined the register of the two churches—the Oude Kerk and the Nieuwe Kerk—at Delft, and extracted all the references to any person whose description showed any connection with pottery. He has thus brought to light and classified a great mass of authentic facts and dates respecting the faïence-makers of the town, which is quite independent of any knowledge derived from the wares themselves.

Before M. Havard had laid down the lines of the subject, and placed at our disposal this invaluable body of unimpeachable evidence, all that was known of the history of the manufacture consisted of some references contained in contemporary works, of a few names, marks, and dates, extracted from the records of the guild, and of a certain number of other marks which had been identified, some on very questionable grounds, and, as we know now, quite erroneously.

All this has been changed, and the student of the ware, having M. Havard's framework on which he can perfectly rely, and being assured of the main facts of the history, is enabled to group his pieces according to their date and maker, with some approach to certainty; and, instead of wandering aimlessly among a wilderness of marks, he has it in his power to supplement the documentary evidence by useful additions to the history of the fabrication.

M. Havard's list, though it contains no less than 763 delft ceramists, is necessarily very far from exhaustive; for example, it is not possible to derive from it a complete succession of proprietors of any one factory, the dates showing at once that there must be numerous gaps. The collector may therefore perform a useful service by noting the existence of a factory mark occurring with new initials, and, indeed, by placing on record any initials or makers' marks occurring upon any piece presumably made at Delft, and which are not identifiable by means of M. Havard's data. No doubt the principal delight of the collector is derived from the contemplation of the objects themselves, associated as they are with artistic or technical or archæological interest, but it is always extremely unsatisfactory when he has to be content with this personal pleasure, and is debarred from the means of contributing to the literature or history of a subject in which he takes a real interest.

I think that any connoisseur in delft would always do well to make a serious study of the wares actually made in Delft—treating them as the standard or criterion with which all other wares made elsewhere were to be compared—whatever further investigations he might make with respect to the products of other localities. M. Havard has provided him with an admirable guide, which is not only a history but a mine of facts, from which he may deduce much additional knowledge for himself. The old town of Delft is so little altered from the time when its canals were filled with barges laden with the wares just carried across the quays from the factories (which were all in the town), that it is very easy as one walks through the quiet streets to-day to picture the scene when the trade was at the height of its prosperity. M. Havard gives the position of the factories and the place of abode of the potters, as extracted from the books and registers, and there is scarcely a street or lane that is not associated with a name or a factory familiar to the collector or connoisseur.

It would be quite unpracticable, I believe, for any one person to attempt a detailed study of delft-ware as a whole, so numerous and widely scattered were the places at which it was made.* At whatever part of Europe one is staying, there is always ample scope for research in the collection and examination of the delft wares, which have been in use in the vicinity. Leaving out of consideration the objects obtained for their quality or artistic excellence, and having regard only to those of antiquarian interest, the collector would probably find it most profitable to restrict himself to the products of a single country or a few localities, and to harden his heart to the Delft wares of minor factories of other places, unless they were remarkable in themselves, or helped to illustrate certain points.

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* In 1789, there were in France no less than 165 manufactories of faïence and porcelain (exclusive of mere potteries) established in 74 towns. Rouen had 16 factories, and was

It is natural in England to pay special attention to the English delft wares, although, as has been pointed out by Mr. Solon, not being original products of the country, they necessarily present less interest than the purely English ceramic work of the 17th and 18th centuries. Still they afford a very attractive and untouched field for investigation, and offer many curious problems for solution.

Taking, for example, the so-called Staffordshire delft dishes, generally ornamented with blue dashes on the border, and painted in the middle with representations of Adam and Eve, King William, William and Mary, &c., why were they of this particular form, why are they without enamel on the back, when were they manufactured, and over what period do they extend? I have never seen any Dutch pieces of the same class, and, in fact, they suggest Italy and not Holland. On comparing a number of specimens, the body of the ware is seen to exhibit so many marked differences that it is evident that these dishes must certainly have been produced in several, and probably in a good many, distinct localities, although no actual places of manufacture can be suggested at present with any show of evidence except Lambeth and Staffordshire.* The limits of date are probably from about 1640 to 1750, but nothing is known, or has been conjectured so far as I know, with respect to the origin of these pieces, either as regards shape or decoration. A collector continually meets with curious and puzzling specimens, but it may safely be said that there are no more interesting or mysterious groups of objects in English ceramic history than these early enamelled earthenwares. But however suggestive the existing specimens of this rough ware may be, it is not likely that anything very definite can ever be ascertained except from documentary evidence or excavations on the site of old potteries.

The course of the development of English delft is peculiarly interesting from several points of view, but especially in connection with the efforts which were being continually made by the delft-potter to imitate in his more cumbrous ware the shapes and styles of the porcelain of Chelsea, of the perforated ware of Leeds, &c. The same attempt at rivalry is apparent also in respect to the transfer-printed designs on stone ware, and I possess a delft plate with a hand-painted attempt at the willow pattern. The reproduction of the styles and designs of Dresden, &c., took place also on the Continent, but the contest between the

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followed by Paris 14, Nevers 12, Marseilles 11, Bordeaux 8, and Moustiers 5. This list of places and numbers of factories is attached to a protest from the French makers of faïence and porcelain to the National Assembly against the treaty of commerce with England (Champfleury: "Histoire des Faïences patriotiques," 3rd ed., Paris, 1875, p. 376). Even if we suppose that France possessed more than its natural proportion of faïence-makers, these figures suffice to show how numerous must have been the localities at which delftware was made in Europe. It is not unlikely that there were many more English factories than has been supposed, and that some existed in parts of the country which have not hitherto been regarded as probable ceramic centres.

* Attention has been drawn to the fact that the subjects represented on these dishes are so few in number, "Adam and Eve" being the only scriptural design, but I do not think that it has been noticed, except by Mr. Downman in his "English Pottery and Porcelain," published last year, that floral decorations, generally tulips, and fruit (grapes and apples) and leaves also occur. The "Adam and Eve" is much the most common of the designs, but the floral and fruit patterns are not infrequently met with, at all events in the Eastern counties. I have, myself, eight or nine specimens, and there are nearly as many more in the Saffron Walden museum. It is to be noticed, however, that the dishes with kings and queens are well known and have been figured in Church's "English Earthenware," and Solon's "Art of the Old English Potter," so that a good many of the existing specimens have already found their places in museums and collections. Several of the tulip designs are very effective and well coloured, but on some of the dishes the colouring is extremely bad and even painful. It is noticeable that green is much more freely used than in the contemporary Dutch work; sometimes it is very good, suggesting the green of Brussels delft, but it is often muddy. The red seems to have been painted above the glaze with a kind of dissolved sealing-wax. This method of applying the red was employed on other pieces of early English delft, and I have specimens in which it has all been worn off except a few specks which just serve to show that it once existed. I believe that many early pieces which now show no trace of red were originally painted in this way. Returning to the "blue-dash" dishes, I may mention that several of mine have been obtained directly from cottages and small farmhouses, and that they seem to have been always used for mere decoration. I have long suspected, what Mr. Downman has suggested, that there must have been a very early delft factory on the Eastern side of the country. These dishes show on their fronts the marks of the three spurs by which the dish above was supported during the firing, the flange of one dish resting upon spurs placed in the one below. In other kinds of English delftware the plates and dishes were supported from underneath the edge by three projections from the side of the seggar, as in the case of the Dutch wares.

cheaper delft and the finer English wares that were to supplant it is more noticeable in this country, and some of the efforts of delft to rival the contemporary porcelain or stoneware form curious records of a struggle to which there could be but one end.

The paper was illustrated by a representative series of examples of Dutch and English delft from the author's collection, and also by some choice specimens of the scarcer kinds of Dutch delft, and of the *faïence* of Rouen and Nevers, from the South Kensington Museum, which were kindly lent by the Science and Art Department.

DISCUSSION.

Mr. FREDERICK LITCHFIELD said he was rather struck by the statement that the first period of delft-ware was that in which they found battle pieces depicted, as it controverted generally accepted ideas, not only with regard to Delft, but every other ceramic factory. Surely all the early pieces of delft and all others were copied from the only masters those early people had, the Chinese. The Dutch were the first who carried on trade with the East, and they copied the Eastern shapes, subjects, and colours. All the vases exhibited that evening, except the square one, were copies of Chinese vases, and they copied very generally the old blue and white Nankin, which was so much in request in the Dutch market. Battle pieces were very rarely seen at all, and when they were seen, if you looked at the costumes, it would be seen that they were of a later date than the older pieces; they were more in the style of pictures getting well on in the 18th century. If the word "delft" were used as generic term, not as meaning the production of the particular town from which it took its name, there were very many other factories which might have been mentioned. They had only heard of Nevers and Rouen, but there were many more as those at Moustiers, Marseilles, Amiens, and numbers of French towns, and also Swiss and German factories. He presumed Rouen and Nevers were only mentioned by way of contrast to the Dutch factory. There was a very good factory still in existence at Nevers, which was carried on upon the old lines and traditions.

Professor MCKENNY HUGHES, F.R.S., congratulated the Society on having laid before it the results of investigation carried on in his leisure hours by one so eminent in the very highest lines of research. He understood that Dr. Glaisher intended to describe only a small selection of typical delft-ware, although the name included much besides; just as Samian ware was, of course, first made in Samos, then in the Abruzzi, then in Gaul, and, doubtfully, in Britain, but was all spoken of as Samian, and the same remark applies to the common use of the word china. There must have been an immense number of factories of delft, hundreds in France, and a good many in England, and it would take a long time to give a full account of them all. It had been explained why they had not more of the intermediate forms. He sometimes thought that jugs and things broke more readily now than they did in his boyhood; if a crack came in the glaze the jug was hopelessly done for, but in his early days he had known a cracked jug to last a long time. He presumed that from the porous nature of the base on which the painting and glaze was laid the vessel did not last. They must, therefore, look on the pieces which were preserved simply as relics, the missing links being far more numerous than what remained in the museums. He should like to ask Dr. Glaisher if he had traced any connection between the earlier delft-ware and the Rhodian, which though very different in pattern was in many respects like the ware now before them. Many of the forms might be found in various countries and of various dates, but it must be remembered that the requirements of a simple dish or basin were much the same through long ages, and were likely to be repeated, the ornamentation becoming more elaborate.

Mr. LEWIS DAY said that he had been very much interested in Dr. Glaisher's paper. Especially he had been interested to learn the way in which the glaze was sprinkled on the Delft. He did not profess to be an expert in the subject, but he had always understood that while the blue colour was painted under the glaze, the other colours were painted on it, and they certainly looked like that to him. It was quite evident that the blue was painted on a very porous body; and where the brush had been a little full, you got little blots of colour; but, as far as his observation went, you never saw that with the other colours; and his conviction was that they were painted on the glaze. With regard to the Rouen ware, it was perfectly obvious that such pieces as the Rouen dishes shown could not be painted in the "slick" way that the delft-ware was. The artist was much more deliberate about his work, and it looked as if he prepared his colour or most likely the body of his ware in some way, so that the colour was not absorbed so quickly. He had been always curious with regard to the green on French and Dutch ware; it seemed to him that perhaps it was produced by painting yellow over the blue. Was that so? It was obvious that the old Delft designs came from China, not only the patterns being copied, but a dash of blue being mixed with the white, so as to give the bluish tinge, like that in the white of the human eye, which was so pleasant. Dr. Glaisher had alluded to one particular piece of delft as being the commonest type of all: to him that plate seemed the most beautiful and effective of them all. It was apparently a solitary instance of the best thing being commercially the most successful. Though the designs on the Rouen dishes were described as lace pattern and so on, he did not think they were inspired by any desire to imitate lace. It was Chinese influence always with French modification. It had always been a mystery to him why people collected old English earthenware: the specimens on the wall did nothing to explain that mystery.

Mr. HUGH STANNUS said that with regard to the Italian influence, to which Dr. Glaisher had alluded, it was known that one of Rafael's pupils was a Fleming; and he might have possessed himself of some engravings of Marc Antonio, and have taken them to the Low Countries. In the "Triumph of Maximilian," by Hans Burgmair, there was a fine collection of costumes, and these were doubtless widely disseminated through the medium of wood engraving. Again, in the old *Chronicles* there were many engravings of fights and battles; and very shortly after there were the copper-plate engravings by Callot, which might be utilised by the potter in his decoration. Dr. Glaisher had referred, in a very happy way, to the "thirstiness" of the ground, drinking in the colour, which called for very deft and dexterous handling of the brush; but there was a similar state of things in the old Greek pottery. In the red-figure vases, the Greeks had to deal with a material quite as absorbent or thirsty; and yet they produced artistic works which were the delight and despair of the English pot-painter of to-day. It was evident that the Rouen work could not have been executed in the quick decided manner which would be necessary with an absorbent ground; and, therefore, they must have been painted over the fired enamel, or rather slip, though under the final glaze.

Miss WEBSTER said when first she knew Whittlesea some thirty or forty years ago, she noticed that there was a street there named Delft, sometimes spelt Delph; and also that you found in any house you entered that the dinner plates, and generally the tea things were of Delft. She could call to mind many tea caddies of the same description as that on the table which were in constant use, but they were all blue, and many of them clouded blue. She had never seen these tea bottles used in anything but delft, pewter, or silver. Whether the delft-ware was made in England or not she could not say; there was no local tradition of there having been a manufactory there; but there was a great deal of traffic between Whittlesea and the Low Countries, it being formerly one of the depôts for smuggled lace, much of which came from the same neighbourhood. There was very little of this ware now left, it being so caught up by collectors from London. Last October, in a house she visited, she found they had only two small basins, a milk jug, and a teapot left. She had also noticed in two or three cases where the teapots had been broken they had silver spouts fitted to them, which went to show that the owners considered them of value.

The CHAIRMAN said there was no doubt the reason why the Chinese and Eastern character was adopted by painters of these delft-wares, was that the importation from China of porcelain threatened the very existence of the inferior wares. The only people who could afford porcelain in early days were the rich, but it gradually became the fashion, and being a most excellent material for every-day use, it was imitated in inferior ware. The inferior material of which delft was made was the cause of its being covered with tin enamel, so as to make it practically useful for domestic purposes; nevertheless the material was a poor one. The tin enamel covered up the softer body, and when a bit chipped off, the dark body underneath was exposed; it absorbed dirt, and soon became an eyesore. No doubt the effort to imitate Chinese ware was made in the hope of stemming, to some extent, the competition arising from the importation of Eastern work. In his youth he remembered perfectly well that in Brittany there were many villages in which this common ware was made; now he believed it was only made in one or two places; but still in the French markets of the present day, even in Boulogne, you would find delft pitchers and cups and saucers, made probably in the neighbourhood. The common delft-ware was still frequently made at the present day, and excellently well made. The common village ware he had seen recently, brought over from Brittany, was exceedingly well done; the glaze was solid and firm, and although it covered the coarser body underneath, would bear a great deal of wear. The most celebrated factory nowadays was that of Canta Galli, at Florence, where imitations of the old majolica were made. The Delft potters no doubt were the men who introduced higher kinds of pottery into Staffordshire, Bristol, and Lambeth. The manufacture existed until recently. He perfectly remembered in the '40's and '50's all the ordinary wares, chemists' slabs for rolling out pills, pomatum pots, jam pots, &c., were made in Lambeth by the ton, but they had now disappeared altogether. Until 1860 there were two slabs in High-street, Lambeth, a cat and dog, about 4 feet high, which were removed when Stiff's factory was rebuilt. He did his best to obtain them, but was outbidden by some richer competitor. The tradition was that they were made at the time that George III. came to the throne. He should like to say a word in favour of the much abused English pieces. He quite agreed that the picture of William and Mary must not be taken as an example of art, but it had a political signification. Dutch William brought many arts to England, amongst others pottery. The potters were Dutchmen and they had a distinctly loyal feeling towards the Dutch king, who protected them, subsidised them, and gave them advantages over their English competitors. The hidden beauty of the thing therefore lay in the sentiment. Some of the other examples were by no means bad designs and they were exceedingly well done. The question of painting on the tin enamel and then glazing it, or not glazing it, was a question entirely of the chemical constituents of the enamel. Some of the ordinary enamels you could purchase at the present day would fuse perfectly into a good glaze, others would require to be glazed. The Rouen and Nevers ware was not glazed, because the tin enamel was so treated that it did not require it. Ten years ago an effort was made in Berlin to introduce Italian workmen to work on tin enamel ware, and it succeeded admirably in every respect except the commercial. The Italian artists were skilful but not too industrious, and could not be induced to work at a reasonable rate of pay. The results were very beautiful, being mainly based on Italian majolica models. This experiment was a practical instance of the ability of this material to apply itself to modern needs. He knew as a fact that no artistic pottery paid, or ever had paid probably, but among the many efforts now made by men of means to restore the old arts it would be quite worth the while of some lover of pottery to re-introduce this beautiful tin enamel ware. He concluded by moving a cordial vote of thanks to Dr. Glaisher.

The vote of thanks having been carried unanimously,

Dr. GLAISHER, in reply, said that his knowledge with regard to the work previous to 1650 was derived from Havard; he had not seen any specimens except in the Amsterdam Museum, and as far as he remembered none of the subjects were Chinese. Indeed, he had been surprised by the fact that the earlier works did not seem to have a Chinese motive. In referring only to Rouen and Nevers he simply took account of the amount of production; of course there were a large number of other places where similar work was carried on. With respect to the meaning of the word *delft-ware* he used it in the sense of including any earthenware that was covered by a stanniferous enamel, whilst in *faïence* he should include Rhodian ware, which had a white-clay wash and an alkaline glaze. Mr. Day had raised all sorts of difficult points about painting over the glaze. He had no doubt that most of the polychrome painting was done under the glaze, and that in delft pieces the red was generally under the glaze, but at Delft they certainly did paint upon the enamel after it had been fired, because the records of the guild contained references to disputes between masters and workmen, arising from this very matter. The green colour might be produced by painting yellow over the blue, or by mixing the colours on the palette. He was glad to hear Mr. Day commend the expanded peacock's tail pattern, it was a favourite one of the late Professor Middleton, who referred to it in his article on Pottery in the "Encyclopædia Britannica." He was surprised to hear of the quantity of delft at Whittlesea. The eastern counties were still the best place in England for obtaining delft-ware, and next in order, he thought, came Sussex and Surrey. Although there was no local tradition, he thought there must have been some factories in the eastern counties; it was difficult to believe that all the delft found there could have been carried from long distances.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 14...Engineers, in the Theatre of the United Service Institution, Whitehall, W.S., 7½ p.m. Professor Herbert W. Umney, "The Compression of Air by the Direct Action of Water."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Papers by Dr. Dupré, Dr. Pauli, Mr. Hudson Maxim, Mr. Alexander Cameron, and Mr. W. A. Davis.

British Architects, 9, Conduit-street, W., 8 p.m.

TUESDAY, JUNE 15... SOCIETY OF ARTS, John-street, Adelphi, W.C., International Congress on Technical Education. 11 a.m. and 2½ p.m.

Statistical, in the Theatre of the United Service Institution, Whitehall, S.W., 5½ p.m. Mr. Alfred Milnes, "Statistics of Small-pox and Vaccination."

Photographic, 12, Hanover-square, W., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. Papers by Mr. Oldfield Thomas, Prof. T. W. Bridge, and Mr. R. I. Pocock.

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Sir George Baden-Powell, "The Financial Relations of the Empire."

Asiatic, 22, Albemarle-street, W., 4 p.m.

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. Discussion on Mr. O. Imray's paper, and paper by Mr. W. J. Spruson.

Electrical Engineers, Conversazione at the Natural History Museum, South Kensington, 9 p.m.

Historical, 28, Jermyn-street, S.W., 5 p.m.

WEDNESDAY, JUNE 16...SOCIETY OF ARTS, John-street, Adelphi, W.C. International Congress on Technical Education. 11 a.m. and 2½ p.m. 9 p m., *Conversazione* at the South Kensington Museum.

Meteorological (in the rooms of the Astronomical Society), Burlington-house, W., 4½ p.m. Papers by Messrs. R. C. Mossman and Charles Harding.

Microscopical, 20, Hanover-square, W., 7½ p.m. Exhibition of Palates of Molluscs.

THURSDAY, JUNE 17...SOCIETY OF ARTS, John-street, Adelphi, W.C. International Congress on Technical Education. 11 a.m. and 2½ p.m.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. Papers by Messrs. Miller Christy, A. D. Michael, Sir John Lubbock, and Prof. C. Macmillan.

Chemical, Burlington-house, W., 8 p.m. Ballot for Election of Fellows. Papers by Messrs. F. D. Chattaway and H. P. Stevens, Dr. J. H. Gladstone and Mr. W. Hibbert, Dr. J. Norman Collie, Dr. A. Lapworth and J. Norman Collie, Prof. T. E. Thorpe, Messrs. C. F. Cross, E. J. Bevan, C. Smith, and Mr. H. Wilson Hake.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Dr. Phené, "Greek and Italian Colonies in pre-Roman Britain, and Græco-Italian Art in pre-Roman London."

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, JUNE 18...SOCIETY OF ARTS, John-street, Adelphi, W.C. International Congress on Technical Education. 11 a.m. and 2½ p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Forty-Third Annual General Meeting for the purpose of receiving the Council's Report and the Treasurer's Statement of receipts, payments and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday, 30th June, at 4 p.m.

(By order of the Council),
Henry Trueman Wood,
Secretary.

ALBERT MEDAL.

The Albert Medal for the present year has been awarded, with the approval of H.R.H. the Prince of Wales, the President of the Society, to George James Symons, F.R.S., "for the services he has rendered to the United Kingdom by affording to engineers engaged in the water supply and the sewage of towns a trustworthy basis for their work, by establishing and carrying on during nearly forty years, systematic observations (now at over 3,000 stations) of the Rainfall of the British Isles, and by recording, tabulating, and graphically indicating the results of these observations in the annual volumes published by himself."

CONVERSAZIONE.

The Society's *Conversazione* was held at the South Kensington Museum, on Wednesday evening, 16th June.

The Reception was held in the Central Corridor of the Museum by Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., Chairman, and the following members of the Council:—Sir Steuart Colvin Bayley, K.C.S.I., C.I.E.; Lord Belhaven and Stenton; Mr. R. Brudenell Carter, F.R.C.S.; Mr. B. Francis Cobb; Hon. Sir Charles W. Fremantle, K.C.B.; Mr. Henry Graham Harris; Mr. James Sewell Neville; Sir Owen Roberts, M.A., D.C.L., F.S.A.; and Professor John Millar Thomson.

Promenade Concerts were given by the Band of the Royal Artillery (Cavalier L. Zaverthal, conductor) in the North Court; by the Red Band (M. Poole, conductor) in the Architectural Court; and by the Euterpean Ladies' Orchestra (under the direction of the Misses Emilie and Annie Scott) in the Textile Court; also a Musical Entertainment by Mr. George Grossmith was given in the Lecture Theatre.

The number of visitors attending the *Conversazione* was 2,310.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The opening Meeting of the Fourth Session of the Congrès International de l'Enseignement Technique was held in the Society's rooms on Tuesday, 15th instant.

Among those present were:—His Grace the Duke of Devonshire, K.G., Lord President of the Council and President of the Congress; Monsieur Léo Saignat, Président du Bureau permanent du Congrès, et délegué de la Société Philomathique de Bordeaux, and Vice-President of the Congress; Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., Chairman of the Council of the Society of Arts, and Chairman of the Congress; John Walter Sugg, Master of the Clothworkers' Company, and Vice-Chairman of the Congress; Monsieur Wauters, Inspecteur-Adjoint de l'Enseignement Industriel et Professional, Belgium, and Dr. O. Pyfferoen, Professeur à l'Université de Gand, Government Delegates for Belgium; Mons. Felix Martel, Inspecteur Général de l'Instruction Publique, and Mons. P. Jacquemart, Inspecteur Général de l'Enseignement Technique, Government Delegates for France; Boris Ovsianikoff, Attaché au Ministère de l'Instruction Publique, Russia, and Gregory Wilewkin, Attaché au Ministère des Finances, Russia.

Also the following Foreign and Colonial Delegates and members of the Executive and General Committees:—Captain W. de W. Abney, C.B., F.R.S., Vice-Pres. Soc. of Arts; Henry E. Armstrong, Ph.D., F.R.S., Professor of Chemistry, City and Guilds Central Technical College; W. E. Ayrton, F.R.S., Dean and Professor of Applied Physics, City and Guilds Central Technical College; Edric Bayley, Technical Education Board, London County Council; Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Mem. Council Soc. of Arts; Prof. T. Hudson Beare, B.Sc., F.R.S.E., Professor of Mechanical Engineering at University College, London; Lord Belhaven and Stenton, Mem. Council Soc. of Arts; Prof. N. Bodington, Litt.D., Principal, Yorkshire College, Leeds; C. W. Bourne, Head Master, King's College School; The Hon. Sir Edward N. C. Braddon, K.C.M.G., Premier of Tasmania; Sir Frederick Bramwell, D.C.L., F.R.S., Vice-Pres. Soc. of Arts; Mons. Albert Breton, Association des Anciens Elèves de l'Ecole des Hautes-Etudes-Commerciales, Paris; George Ledgard Bristow, Mem. Council Soc. of Arts; Colonel Frederick Cardew, C.M.G., Governor of Sierra Leone, representing the West African Colonies; Sir Gilbert Thomas Carter, K.C.M.G., late Governor of Lagos, representing the West African Colonies; Alfred Chatterton, Madras; B. Francis Cobb, Treasurer, Soc. of Arts; Herr Von Diefenbach, Würtemburg; H. F. Eaton, late Under-Treasurer of Victoria, representing the Colony of Victoria; Mons. George Elwall, Professeur, à l'Ecole Superieure Colbert, Paris; D. Ewart, Education Office, Brisbane, Queensland; Mrs. Fenwick, Leeds; Sir Joshua Fitch, LL.D.; Hon. Sir Charles W. Fremantle, K.C.B., Vice-Pres. Soc. of Arts; Sir Douglas Galton, K.C.B., D.C.L., F.R.S., Vice-Pres. Soc. of Arts; Prof. William Garnett, Technical Education Board, London County Council; J. H. Gladstone, Ph.D., D.Sc., F.R.S.; Joseph G. Gordon, Member of Council, Soc. of Arts; Sir John J. Grinlinton; Olaus Henrici, Ph.D., F.R.S., Professor of Mechanics and Mathematics, City and Guilds Central Technical College; Prof. J. Viriamu Jones, M.A., F.R.S., Vice-Chancellor, University of Wales, and Principal and Professor of Physics in the University Coll. of South Wales and Monmouthshire; Right Hon. Sir John Lubbock, Bart., M.P., F.R.S.; Sir Philip Magnus, City and Guilds of London Technical Institute, and Adviser to the London Polytechnic Council; Julien Manès, Directeur de l'École Supérieure de Commerce et d'Industrie à Bordeaux, Secrétaire Général du Congrès, 1895; C. T. Millis, Principal of the Education Department, Borough Polytechnic; Hon. William Wilson Mitchell, C.M.G., representing the Colony of Ceylon; Right Hon. A. J. Mundella, M.P.; Gottlieb Nilsen, Norway; Mons. Armond Olive, Professeur de l'Association Philotechnique, Paris; Right Hon. Sir Richard H. Paget, Bart., Somerset County Education Committee, Weston-super-Mare; Ralph Palmer, Worshipful Company of Mercers; A. Pedler, Calcutta; Sir Westby B. Perceval, K.C.M.G., Agent-General for Tasmania; Gilbert R. Redgrave, Chief Senior Inspector, Science and Art Department; Rev. J. E. Reece, Inspector of Schools, representing Barbados; Sir Owen Roberts, D.C.L., Treasurer Soc. of Arts, and Chairman of the London Polytechnic Council; Rev. A. Robertson, D.D., Principal, King's College, London; Sir Henry E. Roscoe, D.C.L., F.R.S., Vice-Chancellor of the University of London; Robert Russell, Senior Superintendent of Schools, representing the Colony of Natal; Edouard Sève, Consul-General for Belgium; Monsieur Jaques Siegfried, President of the Commercial Section of the Congress, 1895; Alexander Siemens, M.Inst.C.E., Mem. Council Soc. of Arts; Swire Smith, Royal Commission on Technical Education; Gerald Strickland, representing the Colony of Malta; W. E. Sumpner, D.Sc. Principal, Municipal Technical School, Birmingham; Mons. L. Suttle, M.A., Société Philomatique de Bordeaux; Silvanus P. Thompson, D.Sc., F.R.S., Principal and Prof. of Physics, City and Guilds Technical Coll.; Dr. Walmsley, Principal, Northampton Institute, Clerkenwell; Sidney H. Wells, Principal, Polytechnic Institute, Battersea, S.W.; Prof. J. Wertheimer, B.Sc., B.A., Hon. Sec. Association of Technical Institutions; Sir William C. Windeyer, M.A., LL.D.; William Woodall, M.P.; Dr. R. Wormell, M.A. (Head Master Central Foundation Schools of London), College of Preceptors; and Sir Henry Trueman Wood, Secretary.

There were also present a large number of Representatives of County Councils and Educational Institutions from all parts of the United Kingdom, a complete list of whom will be given in the proceedings of the Congress to be published later on.

Sir Owen Tudor Burne, G.C.S.I., K.C.S.I., Chairman of the Council, introduced M. le Professeur Leo Saignat, President at the last Congress at Bordeaux, who addressed the meeting as follows:—

Mesdames et Messieurs,

Je suis heureux de voir s'ouvrir à Londres le quatrième Congrès International de l'Enseignement technique, commercial et industriel, et je suis très honoré d'être appelé, comme Président du Congrès précédent, à souhaiter la bienvenue à l'illustre Président du Congrès actuel, Monsieur le Duc de Devonshire, Lord Président du Conseil. Je regrette seulement de ne pouvoir m'exprimer en anglais. La réunion du Congrès dans la capitale de l'Angleterre

réalise un vœu que j'exprimais en 1895 lorsque j'ouvrais à Bordeaux le troisième Congrès. Les trois premiers Congrès avaient eu lieu en France; le premier à Bordeaux, le deuxième à Paris, et le troisième à Bordeaux. En constatant les heureux résultats de ces trois Congrès non-seulement pour la France, mais aussi pour d'autres pays où une vive impulsion avait été donnée à la création d'écoles spéciales pour le commerce et l'industrie, j'ajoutais: "Il ne faut point perdre de vue que nos Congrès sont "internationaux et qu'ils doivent garder ce caractère "pour conserver toute leur utilité. Si les Congrès se "réunissaient toujours dans le même pays on pourrait "craindre que l'uniformité amenât la lassitude et que "l'on se rendît moins nombreux dans les Congrès, "qui perdraient ainsi une partie de leur autorité. Il "est donc désirable que des Congrès semblables se "réunissent dans d'autres pays." Ce vœu est aujourd'hui réalisé par l'Angleterre. Aucun pays ne pouvait offrir au Congrès un plus beau champ d'études; aucun ne se distingue par une plus grande activité commerciale et industrielle, par une intelligence des affaires plus puissante et plus fèconde. Nul pays n'est plus à l'affût des progrès de la science et ne sait en tirer plus rapidement d'importantes utilités. La Société des Arts était elle-même bien placée pour continuer l'œuvre commencée à Bordeaux par la Société Philomathique, et je lui suis reconnaissant d'avoir bien voulu s'y prêter. Le Congrès qu'elle a organisé avec le concours de plusieurs corporations de cette grande cité, marquera sa place dans les annales de l'Enseignement commercial et industriel. La liste des hommes distingués qui se sont fait inscrire pour y faire des communications en est un sûr garant. Je suis heureux d'y voir les noms des deux représentants de l'Angleterre aux deux Congrès de Bordeaux, Sir Philip Magnus, et Monsieur Gilbert Redgrave. Les illustres personalités que vous avez placées à la tête du Congrès le Lord Président du Conseil, Monsieur le Duc de Devonshire, Sir John Gorst, Vice-Président du Conseil, et le Major-Général Sir Owen Tudor Burne attestent l'intérêt que l'on porte dans ce pays aux œuvres du travail. L'enseignement technique est avant tout une œuvre du travail. Il tend à rendre plus facile et plus fructueux le travail de ceux qui se destinent au commerce et à l'industrie, en mettant à leur disposition les découvertes incessantes de la science qui jettent chaque jour dans le monde des éléments nouveaux de production et offrent à l'activité humaine des procédés nouveaux, réduisant à l'impuissance et à la stérilité les efforts de ceux qui ne se mettraient pas au courant des découvertes nouvelles. A notre époque, où le travail est le principal ressort du succès et de la vie, tout ce que l'on fait pour le rendre plus facile et plus fructueux est une œuvre de bien public. Dans le temps actuel où les luttes des classes sont si vivement engagées, où des passions mal raisonées tendent à oblitérer le principe de la solidarité humaine, où beaucoup croient voir des oppositions d'intérêts là où il y a au contraire concours mutuel à une utilité commune, il est méritoire de chercher à éclairer le travailleur à lui rendre le travail plus facile et par suite moins pénible, et en l'y préparant par de solides études à lui éviter les déceptions et le découragement que causent les efforts infructueux. Mais je ne veux point Messieurs anticiper sur le Congrès. Je laisse à une voix plus autorisée que la mienne le soin d'en tracer les grandes lignes, et j'ai hâte de lui céder la parole. Le Lord Président du Conseil apportera au Congrès dont il a accepté la présidence l'autorité de sa haute situation personnelle et de l'approbation du Gouvernement dont il fait partie. En acceptant la présidence de ce Congrès, il a manifesté son amour du bien public et mérité la reconnaissance des travailleurs de tous les degrès et de tous les pays. Permettez-moi Messieurs en terminant d'addresser un respectueux hommage à Sa Majesté la Reine, dont le long règne que la reconnaissance nationale célébrera dans quelques jours par des fêtes mémorables, a si puissament contribué à la prosperité toujours croissante de ce pays.

The Duke of DEVONSHIRE, K.G., then addressed the meeting. He said:—

It is in a double capacity that I have the honour of offering a welcome to the International Congress on Technical Education. We have in this country a Department of Education, but its functions are almost entirely limited to elementary education, and we have not in our administration any Minister who properly corresponds to the Minister of Education of other Governments. Nevertheless, the President of the Council is the Minister on whom the nearest approach to responsibility for education rests, and the Vice-President, Sir John Gorst, is the Minister who, representing as he does the Government on education matters in the House of Commons, shares with the President a large part of his responsibility. It is, therefore, partly in our official capacities that Sir John Gorst and I are taking part in these proceedings. But the comparatively unorganised condition of education as a whole has led to the formation of various unofficial and irresponsible associations with the object of promoting and helping to organise special branches of education to meet the growing needs of the country. Of these, the National Association for the Promotion of Technical Education is one in the establishment of which I, though no educational expert, have taken some part, and of which I am still President. I shall have a few words to say on a part of the work which has been done by this Association, before I conclude, but I refer to it now as explaining my presence on this occasion. It is due, however, to the public spirit, and to the active assistance of another of those voluntary associations to which I have referred, that it has been made possible to hold in London, this, the fourth meeting of the International Congress on Technical Education. Founded more than 100 years ago (in 1754), and incorporated by Royal Charter 50 years since (in 1847), the Society of Arts has, with a varying measure of success, and with varying public recognition and

support, been engaged in many different directions in the encouragement of the arts, manufactures, and commerce of the country. By the discussions which it encouraged, by its publications, by the competitions which its prizes stimulated, it has done much for each of these objects, and to create in the country a recognition of the practical value, as well as of the scientific and artistic interest, of the application to business of science and art. Without directly undertaking the work of teaching, it took a leading part in bringing about the International Exhibition of 1851, the parent of innumerable other international exhibitions, which have, perhaps, given a greater impetus to scientific, artistic, and technical, and even elementary education, than anything else. And it is directly to the Society of Arts that the meeting of this Congress in London is due. When it was suggested that the next meeting in succession to those which had been held uniformly in France should be held in Great Britain, the Government, through the Science and Art Department, regretted that it was impossible for them to issue invitations. The Society of Arts took up the matter on the condition that the Government would give it such recognition as they could, and this has been offered by the semi-official help rendered by the Foreign Office, and by the presence, whatever it may be worth, of myself to-day. But another difficulty remained. The Society of Arts did not command funds which would have met the necessary expense of the Congress, and the Government had no funds which could be placed at their disposal. The difficulty has been solved by the generosity of the City Companies, who, not for the first time, but in addition to splendid assistance in other directions, have proved the strong sense which they entertain of the value to industry and to commerce of an extended scientific, artistic and technical education, and have guaranteed the needful expenditure. The City Companies to whom we are indebted, and to whom I desire, in the name of the Conference, to tender our hearty thanks, are the Mercers, Fishmongers, Drapers, Goldsmiths, Merchant Taylors, Vintners, Clothworkers, Leathersellers, and Carpenters. Turning to the business of the Congress, its previous assemblies have done much to increase public interest in the very important question of technical instruction; and the well-arranged and representative programme of the present Assembly, justifies the hope that its deliberations on the present occasion will be no less fruitful than in the past. In the history of more than one grade of English education, public conferences held at suitable times have been highly beneficial to the public interest. They bring the leaders of the education world into personal contact with one another and promote the useful interchange of opinions and experience. The reports of the discussions in the newspapers and the subsequent publication of their proceedings deeply influence public opinion and help to guide the policy of Parliament and of the administrative Departments of State. The present time is well-chosen for an international congress on technical instruction. In all countries there are signs of increasing interest in foreign methods of education. Systems of education, indeed, cannot be transferred ready made from one country to another. Education is a thing too closely interwoven with national life and habits to permit any such easy transference. A national system of education grows up in natural adaptation to the peculiarities of national character and owes its chief virtues to the fact that it fits the habits of thought and the political conditions of the country which it serves. But, when every allowance has been made for this, it remains true that each country can learn very much from the experience and the educational organisation of other countries. Educational ideas and ideals may be communicated, although systems of administration cannot be transferred without great modification and adjustment to special circumstances. We find, therefore, that in point of fact, English education has been materially affected during the last sixty years by a succession of waves of foreign influence coming in succession from France, Holland, Germany, Switzerland, America, and Scandinavia. And, in some respects, there is no department of education in which methods of teaching and plans of organisation can be more readily transferred from one country to another than is the case in technical instruction, which is the subject of the present Congress. In many respects, this country has been the debtor in this long process of foreign educational exchange. But there is one point at least in which continental critics are now paying Great Britian the compliment of careful study and even of admiration. The need for individual initiative and for freedom of local experiment has always been fully recognised in English education, and in no grade of it has this been more the case than in technical instruction. We have recently been working out an interesting and fruitful experiment in combining financial aid from the central exchequer with great liberty of action and experiment on the part of the County and County Borough Councils. The policy of the Government in 1890, in permitting local authorities to expend their share of the residue of the excise duties on technical education has probably done more than any previous act of the State to stimulate national interest in technical instruction, and, indirectly, in other forms of education also. While the central Government, through its administrative departments, has not failed to give a certain measure of guidance to the new movement, it has thrown the greater part of the responsibility on the local authorities, believing that (in technical education especially) there must be great elasticity in administration, and incessant adaptation of the means and form of instruction, in order to meet the great variety of the industrial and commercial needs, which exist in the different localities but can only be ascertained and fully tested by local experiment. The local authorities have, with few exceptions, risen to their new responsibilities with an alacrity and enterprise which deserve high commendation. But they have also felt their own inexperience, and have not only taken counsel with one another but have sought the advice of persons qualified to advise them. They have thus, I hope, derived much assistance from the National Association for Promoting Technical and Secondary Education, to which I have already referred, and to which Mr. Mundella, Mr. Arthur Acland, Sir Henry Roscoe, Mr. Llewellyn Smith, and many others have rendered distinguished service. It is characteristic of England that a society, formed by private initiative but embracing in its membership a large number of men holding public positions, should have rendered this important service at a critical stage in the history of our educational development. Equally notable is the fact that so many of the ancient City Companies should now be reviving, in a manner fitted to the changed conditions of modern life, their old conditions of commercial and industrial usefulness. All of those who are labouring for the extension and improvement of technical instruction in Great Britain—as well as in Ireland, where a remarkable movement is now in progress for the furtherance of technical education—will learn much from the reports brought by the foreign delegates. They will also take special interest in the accounts to be given by distinguished visitors of technical education in Canada, in India, and in Australasia. To British hearers, probably, no part of the discussions will be more instructive than that which is to be devoted to the subject of commercial education. In the field of higher commercial education, Great Britain is believed by many competent observers to be seriously behind several of the Continental nations. The reputation of the French schools of commerce stands deservedly high, and the Congress is to be congratulated on the prospect of hearing, from so eminent an authority as M. Jaques Siegfried of Paris, and M. Saignat, the late President of the Congress, an account of higher commercial education in France. Attention will also be usefully directed to the influence of the Realschulen of Germany and especially the Realschulen of Berlin, in producing, by means of a carefully planned modern secondary education, given by trained teachers of the highest attainments, an increasing nnmber of youths eminently fitted to profit by the highest kinds of technical education and to promote the commercial interests of their country. The present Congress is held at a time specially interesting to all the English speaking world. The long reign of Her Majesty has practically coincided with a great series of efforts, public and private alike, to build up a national system of education in this country. The work is far from completed. We are now on the threshold of a period which promises to be full of educational activity and re-organisation. It is of happy augury that it opens with a Congress at which the representatives of many nations will meet together in friendly debate on subjects which are of deep moment to all alike.

As the Duke of Devonshire was compelled to leave the meeting, General Sir OWEN TUDOR BURNE took the chair. He then proposed a vote of thanks to his Grace for having shown the sympathy of the Government with their Congress by his opening it with so interesting an address. The motion was seconded by M. JACQUEMART, and unanimously agreed to, and his Grace briefly acknowledged the compliment.

Sir OWEN BURNE said that he had very little to add to the admirable addresses just delivered by Mons. Leo Saignat and the Duke of Devonshire. He would like to remind the meeting, however, of certain details connected with the Congress, and these he described in extenso. He remarked that education was the source of happiness to every human being, and to those with whom each individual came in contact; it must be remembered, nevertheless, that education could only be complete when practical knowledge was added to that which was theoretical, and this he understood to be the object of the Congress. He wished to add that it gave the Society of Arts and the City Companies very great pleasure to give a hearty welcome to the Congress now assembled, and to say how gratified they were to receive so many distinguished Foreign Delegates who had taken the trouble to come to London to attend it. Then turning to Mons. Saignat he said in French:—

Je vous prie, M. Saignat, d'accepter de la part de la Société des Arts, et des City Companies, comme aussi de la mienne, l'assurance que cela nous fait le plus vif plaisir d'avoir l'honneur de vous recevoir à ce Congrès—vous et vos distinguès confrères. J'espére bien que vous trouverez nos discussions interressantes et instructives; et, surtout, que vous emporterez à votre départ un bon souvenir de votre sèjour en Angleterre.

The CHAIRMAN then proposed a vote of thanks to M. Saignat for his address, and to the foreign delegates generally for their attendance.

Sir DOUGLAS GALTON seconded the resolution, and it was cordially carried.

M. SAIGNAT, replying in French, said that he keenly regretted his inability to address them in their own language. He had, however, understood a little of what had just been said, and the little he had understood enabled him to know that they had overwhelmed him with thanks. He and his colleagues were extremely sensible of all the kindness which they had received. It was with them a privilege and a pleasure to be able to come amongst the *savants* of London, and especially to be so cordially received by them. They had been in London as yet but a short time, but nevertheless they had been touched by the manner in which they had been generously received with open arms, and he thanked them all very much.

M. JULIEN SUTTLE, of Bordeaux, wished to say a few words. There was in Paris a society called the English and French Association, and its annual meeting took place on May 21st last, the English Ambassador and Lady Monson, and the French Minister of Public Instruction being present. The object of the Association was to bind more closely together the ties between the two countries, and he was deputed by the Society to say that they were animated by those cordial sentiments. They were particularly pleased when they read the programme of the present Congress, with its long list of distinguished members of English Society and the English nobility, for it showed that they were in reality a true and genuine nobility, to interest themselves in the proceedings of such a Congress. On the part of his Society he wished long life to her Majesty the Queen, and to all of them.

The papers announced were then read, and a discussion followed.

The papers and report of the discussion at this and the subsequent meetings will be printed in future numbers of the *Journal*.

Proceedings of the Society.

CANTOR LECTURES.

THE INDUSTRIAL USES OF CELLULOSE.

BY C. F. CROSS.

Lecture I.—Delivered February 15, 1897.

As a necessary incident in close upon twenty years of work in the province "cellulose," I have called attention to particular aspects of the subject of cellulose, scientific and industrial. When honoured by the invitation of the Council of this Society to take up a position on a wider platform, I was pleased to note the recognition by the Society of the growing importance of the subject, and also on the personal side to be credited by implication with an interest in the subject fully sustained and not dulled by the influence of routine occupation. In accepting the invitation of the Society, I submitted alternative titles for the course of lectures, and the title announced, which was selected for me, I take as a recommendation of the mode of treatment of a many sided subject most consistent with the aims of the Society of Arts. In adopting the recommendation I intend to subordinate scientific to industrial questions. To those who regard this as a reversal of the "natural" order, I would point out that in the larger natural order, *i.e.*, the actual world, the cart generally does precede the horse, and especially has this been the case in the cellulose industries. As a further apolgy for what they may regard as a concession, I may remind them of a work on "Cellulose" which I, with my partners, have recently published, in which the subject is treated on the stricter view of its true present-day perspective. In it and by it we certainly intended to drive a few more nails into the coffin of empiricism, and to make it clear that future developments demand from would-be pioneers that their hope or rather perhaps conviction of success, lies in mastering the science of the subject as it stands and working from that undiluted standpoint. Those who take such a view will hear or read these lectures with the matter of previous publications in their mind, and will therefore excuse a reiteration of familiar subjects or arguments.

As these remarks involve the wide question of the relation of industry to science, a matter engaging public attention at the present time, I may perhaps be allowed a short preliminary digression thereon. We English people have been called, somewhat flippantly perhaps, "a nation of shopkeepers." But there is a justification of the epithet in the manner in which the question of "technical education" is being presented to the public. We are urged by platform speakers, largely of the "political" order —an order which in this country is supposed to possess, *ex officio*, omniscience—to address ourselves to the scientific basis of production. First, as a means to increase income; secondly, to beat off the competition of other countries, notably Germany. The appeal is made chiefly to the wage-earners of the country, and the kind of "education" considered is chiefly the acquisition of wage-raising accomplishments. The local colour of the agitation is "of the shop, shoppy." The wrong motives are challenged, and the "mission" is to the wrong class. It is "capital" which wants education, and the manufacturers who should be urged to go on setting their houses in order. "Labour" is intelligent enough—*i.e.*, practical enough—to rise to every opportunity created by the higher order. And the higher order are in the position to act from the higher motives. Increase of revenue, expansion of profitable production, are the incidents of order and method applied to the routine of manufacture on the one hand, and enterprise in new directions on the other.

To put the matter more practically: The capitalist and manufacturer on this view must avail themselves of the services of scientific men. It is the business of the scientific man in a mill or factory, *qua routine*, to keep technical order; and, *qua enterprise*, to keep the "heads" fully informed of new movements from outside and by investigations, whether in adopting these or in devising his own, to ensure steady growth of improvement or expansion. This is the work of the "intelligence department" of the factory. Moreover, since experimental trials are part of its routine, and experiments disturb the ordinary routine of production, there must be a corresponding organisation—a methodical way of experimenting with the minimum of disturbance. It is not a fitting opportunity to enlarge upon this theme, but it is not out of place to mention it in connection with my subject, for my experience of the cellulose industries shows me that we have a great way to travel before this essential and fundamental relationship of science to industry is generally grasped and practically adopted.

The industrial uses of cellulose are so familiar to us that they probably fail to suggest, to the untrained mind, any adequate idea of their variety, vastness, and absorbing technical interest. A few considerations, under these heads, are necessary to delimit the area of our inquiries. As to variety our subject-matter includes the following industries: papermaking; the textile industries, *i.e.*, the manufacture and treatment of cotton, flax, rhea, jute, hemp, for the production of yarn, thread, cloth, and the twine and rope-making industries which employ as raw materials, in addition to the above, manila, sisal, phormium, and other fibres of monocotyledonous origin; the manufacture of explosives, of which the nitrates of cellulose and allied compounds are important staples; the manufacture of celluloid, xylonite, collodion, and the new "artificial silk" or lustra-cellulose. In addition to these the industries in woods must be included, and agricultural industry especially in regard to the growth and use of fodder plants, and as a necessary incident also the production of the staple raw materials of the fibre industries.

Next a few facts and figures by way of a more positive definition of the vastness of these industries, or some of them.

The cotton trade was estimated in 1883 to employ in the United Kingdom 42,000,000 spindles: these spindles working up per week a weight of cotton represented by 71,000 bales of 400 lbs. each, amounting for the year 1881-82 to 1½ billions of pounds. The exports for that period amounted to 245 millions of lbs. of yarns, and 4½ billions yards of piece goods. For 1894 the exports showed a rather less weight of yarns, but the piece goods had increased to over 5¼ billions of yards.

The Irish flax trade is estimated to employ 800,000 spindles. The imported flax for this manufacture in 1893 was valued at £2,517,953, and the exports of manufactured linen goods for that year amounted in value to nearly £5,000,000.

The jute trade, chiefly carried on in Dundee, imports raw material to the value of over £7,000,000.

The paper trade of this country is carried on in 300 mills, and with an average output of 50 tons per week, the production of paper would be 15,000 tons per week.

Lastly, in evidence or illustration of the "absorbing technical interest" of these industries. As they largely involve chemical science it is of interest to note the extent to which the services of chemists are enlisted. We are informed on good authority that the paper trade of this country employs at least ten chemists, at salaries in some cases exceeding £100 per annum. That section of the textile industries which has to do with bleaching and finishing also occasionally employs a chemist and similarly with due regard to economy. In the printing and dyeing industries the chemist is more of an "institution;" but a chemist at the head of an intelligence department is a distinguished exception.

In the more special industries connected with the "nitro-celluloses" the chemist is, we believe, regarded as a necessary item in the establishment.

From a chemist these reflections may appear to have a personal aspect, and we will, therefore, pass to the impersonal side of this question. The technical interest of the celluloses begins with the problems centring round their origin. They are the structural elements, the skeleton or framework of the plant. They occur in endless varieties of form and condition of aggregation, and taking "cellulose" in its widest acceptation, present us with variations in composition and constitution profoundly attractive to the chemist. Then in the uses of cellulose we have many object-lessons of the interdependence of the vast sections of the organic world. Thus, to put it geographically, we have Manchester drawing its staple from America, Egypt, and India; Dundee again dependent upon India for its industrial life; our paper mills supplied from Africa and the forests of Scandinavia, Germany, and America; our rope-making industries drawing supplies from every quarter of the globe. Then we have the extraordinary variety of the industries arising out of the special properties of cellulose. Our very civilisation closely bound up with it, and war, in the modern sense, impossible without it. In the more special sense we shall find that the chief technical interest of our subject belongs to it in its capacity of a chemical individual. There is a wealth of interest in its industrial present and the underlying chemistry which conditions its preparation and uses; and in regard to the future and the many probabilities or certainties of development few subjects are bigger in promise. As it is the main purpose of these lectures to promote the more general recognition of cellulose technology, we need not enlarge on this theme in general terms; we must trust to our subject-matter to enforce the text and point the moral.

As a certain classification of matter is necessary, we must select a basis, and we cannot do better, in view of our opening declaration, than adopt the basis of values—*i.e.*, money values. On this view paper takes the first or lowest position, with selling values of, say, ¾d. to 10d. per lb. for the great bulk of the production. The textiles from natural fibres we may take as a second group, with average selling values of 3d. to 2s.; and lastly, we have a miscellaneous class of special products, including celluloid in its various forms, solids and films, explosives, and artificial silks, with selling prices up to 9s. per lb.

Before we enter upon the special treatments of the cellulose industries, a brief survey must be taken of the present position of the industry in the vegetable fibres themselves, the necessary materials.

In any view we may take of the large subject of vegetable fibres in relation to industry and commerce, the first fact which must strike us is the extremely limited number of fibres which find application. We know, of course, that the number of fibre-yielding plants is very large—thus of Indian plants alone more than 300 species have been actually investigated in regard to their claims for elevation to the select group of those which yield commercial fibres. We know also that not only is the demand for fibres a steadily increasing one in the aggregate of long-established industries, but new and important applications are being brought to light as we grow in our appreciation of the structural and chemical properties of cellulose products. But the number of fibres supplying the demand does not grow. This looks like a disappointing result. A number of promising fibrous products have been from time to time put before the technical public, prophecies and prospectuses have been indulged in, and some consequent industrial failures have to be chronicled. It is time, we think, to inquire into these negative and repeated experiences. Upon first principles we need not enter upon such a task in any pessimistic spirit, for it is the happy quality of "science" that it knows no disappointments, and a scientific inquiry into the problems suggested by the evident difficulty of securing a foothold in industry for new fibrous products will be profitable, even though it means spending a little more time and energy on the "unprofitable."

The ground has been well prepared for this discussion by the very able treatment of the subject by Dr. Morris in his Cantor lectures of 1896. I need not say more of the substance of those lectures than that we who work in this field take them as a standard contribution to the subject of considerable value and coming at an opportune moment. Ten years have elapsed since the holding of the last Colonial and Indian Exhibition, at which the subject of vegetable fibres received a fair amount of attention; and Dr. Morris's lectures gave us a basis upon which to measure industrial progress in this department during an important period. Again we are confirmed in our view that extension and development has not been in the direction of an increase in the number of fibres finding industrial use. It becomes more and more a practical question, "Why this limitation?"

In the first place, it is to be noted that the vegetable fibres available for use by man are not unique amongst the products of the plant world in constituting a "select" class. From an extremely interesting address of Professor

Goodale, of Harvard, U.S.A., delivered as President of the American Association for the Advancement of Science, 1891, we learn that of the approximate total of 110,000 of named species of flowering plants only some 300 are actually cultivated as useful plants, and not more than 1,000 come into the select region of the economic botanist; in other words, of the flowering plants less than 1 per cent. have any present industrial value, and "industrial value," as generally applied to the plant world, covers such multifarious products as gums, resins, dyes, oils, tanning materials, pharmaceutical products, timbers and woods, food and forage plants and fibres.

Starting from this basis of present day uses of vegetable products, Professor Goodale discusses some of the causes of this surprising limitation in numbers, and deals with the problem of probable future extension. He devotes a small section to the special consideration of fibrous plants, but makes no claim to a full treatment of the subject. Generally we are reminded that selection of species has been worked on the capricious basis of chance or accident. Upon a few of these salient points we quote Professor Goodale's own words. "It seems clear that, except in modern times, useful plants have been selected almost wholly by chance, and it may well be said that selection by accident is no selection at all." This statement suggests the basis of Professor Goodale's inquiry which is to forecast the probable results of systematic selection and generally of exhaustive physiological investigation applied to the development of the "useful" qualities of typical plants.

Thus, of the most important group of cereals, he says:—

> "The species of grasses yielding these seed-like fruits, or more shortly, seeds, are numerous; 20 of them are cultivated in the old world, of which six only are familiarly known . . . . with the possible exception of rice, not one of the species of cereals is certainly known in the wild state. It is not in our power to predict how much time would elapse before satisfactory substitutes for our cereals could be found. . . . We are as badly off for time ratios as are the geologists and archæologists in their statements of elapsed periods."

Then follows the friendly challenge:—

> "Why is it that our experiment stations and other institutions dealing with plants and their improvements do not undertake investigations like those which I have sketched? . . . . The reason is plain. We are all content to move along in lines of least resistance, and are disinclined to make a fresh start."

These considerations apply with equal force to fibrous plants, and it is necessary to draw and enforce two very practical conclusions.

1. That the factors of industrial value of a fibre are extremely numerous; each factor is essential, and failure in any one amounts to total disqualification.

2. It is quite possible, therefore, that the natural supply of fibrous materials, uniting these numerous and necessary qualifications, may be exhausted in the sense that no new species are available, and it is equally certain that for the introduction of new fibres a long antecedent course of cultivation and selection of the parent plant is required.

The conclusions we must justify by the consideration of a few important details.

The factors of value, or rather utility, of a given fibre are as follows:—

1. The question of supply. This involves the contributory questions of yield—*i.e.*, proportion of fibre to whole weight of plant, and, therefore, yield per acre under cultivation; separation from the plant by a suitable mechanical process, transport from the locality where produced to the consumers' market. The whole summed up in market price to the consumer.

2. The question of structural features. These absolutely regulate the spinning properties of the fibre. For the highest uses we have as prototypes cotton and flax. Cotton is one of those brilliant exceptions which we frequently meet with in attempting to classify natural quantities. It is a seed hair and a development of the parenchymalous tissue, not of the ligneous elements, which provide the more rigid and strength-giving qualities to plants. We should not, therefore, expect to find many cottons in the vegetable world. With its exceptional physiological characteristics, it is unique in occurring in the form of ultimate fibres. The cotton fibre is the spinning unit. The flax fibre is compound; it is an aggregate or bundle of the ultimate fibres or spinning units.

But these bundles or filaments offer little resistance to hackling and combing—the first processes of preparation of the spinner—and they yield still more completely to the processes of wet spinning. Hence the high level of the spinning quality of flax.

From flax there is a great fall to the much-vaunted rhea fibre. The flax fibres are very uniform in length; they are circular or prismatic in section, with a smooth and regular contour. The rhea fibres are very irregular in length (50-200 mm.), and though much longer than flax, have this advantage at the expense of the much greater disadvantages of irregularity. This involves a different system of preparation for spinning. Moreover they are much larger and more variable in cross section.

From rhea to hemp there is again a fall, similarly the expression of structural inferiority.

From hemp to jute there is a gap, not of difference, but of distinction. So far as this is structural, it is a change of length of the untimate fibre from 20 to 2 mm.; and in chemical composition there is an equally striking change of class, which will be considered subsequently.

From the above four fibres, which practically cover the whole present day field of productions of woven materials in Europe, there is again a gap in passing to the twine and rope industries. For these industries there are available, in addition to the above, the group of fibres derived from monocolyledonous plants. These are much more complex structures: instead of 3 to 12 untimate fibres in the bundle or filament, 40 to 100 is a common average. This constitutes a sweeping limitation or exclusion, and in setting out to find new textile fibres we should never go to this group of the vegetable kingdom for the suggestion of a probable substitute for flax, hemp, or rhea. In paper-making raw materials there are obvious reasons why such structural points are of less moment. The questions involved here fall mainly under the first and last sections.

3. This third and last important item in the "specification" of a plant fibre, considered as an industrial raw material, is that of chemical composition. Broadly, this question resolves itself into that of resistance to the "natural" agencies of destruction always tending to break down organised substances, and which extracted from Carlyle his cynical description of man as a race of "patient dust grinders." This question will be dealt with in detail in relation to the practical subject of the life or longevity of papers, and it need, therefore, be only mentioned here.

When it is considered, therefore, that a fibre in matriculating for the industrial university has to pass a searching examination in all of three independent branches of attainment, each involving momentous side issues, we need not be surprised at the fractional proportion of passes; and we venture to think that our two conclusions drawn from the present position and past history of the subject of the vegetable fibres is fully justified by this analysis of the factors of utility. We appear, in fact, to have arrived on the one hand at a stage when individual enterprise or private venture is at a hopeless discount in attempting pioneer work in regard to a new supply of vegetable fibres. We cannot record this conclusion without regret because it forecasts the extinction of an interesting class of enthusiasts. We all know, for instance, the discoverer of the wonderful properties of the rhea fibre. He is one of a numerous class. How often have we seen the silvery filasse produced from the paper parcel and noted the thinly veiled exaltation with which we are informed of the secret process of treatment? How often have we encountered the superior look accompanying evasive answers to our questions on such details as supply, cost of production, spinning capabilities, and so on. It is not without such regrets that we adopt the conclusion on the other hand that pioneer work in this region must be undertaken by corporations and by systematic, organised investigation.

Each age must accept the facts belonging to it. This age is certainly one of industrial and scientific corporations, but if the individual counts for less, individual qualities count for more, and organised research work cannot be carried out on mechanical principles.

Practically it comes to this: pioneer work in the domain of vegetable fibres is undertaken in this country at several centres. I need only mention the more prominent contributors. The unique institution of Kew Gardens, which well merits on its records the designation of "Imperial." Then the "Imperial Institute" of later creation, which has already done valuable work, and which, if adequately supplied with funds would no doubt rise to a sweeping and enterprising programme in the province of the fibre industries.

Then, again, we must not omit to mention the representative firm of Messrs. Ide and Christie on the "City" side of the question, a firm which has the honourable tradition of uniting with their trading enterprise in fibres, the application of "high scientific principles," fortified by the skilful use of the microscope and a sound criticism based upon long experience. Here are three active centres of work; but neither could command any special means for such exhaustive investigation as we are venturing to forecast. The practical question, therefore, is one of organisation. Outlying centres at the sources of production are ready to hand. India has done valuable work, and various colonial centres have contributed. The association of these in working connection should not be difficult of accomplishment.

We all know what is wanted in such matters. It is not bricks and mortar, it is not the vague and uncertain influence known as "red tape," but workers and means.

The time may not be ripe to discuss such a scheme in detail. It may be considered presumption to have ventured as far as this. The purpose of this brief discussion is to contribute to the formation of a public opinion. Surely, what Germany can do in a generation in improving the sugar-beet and creating a new industry, this country can do in regard to its capabilities of supply of raw material for the vastly more important cellulose industries. An enterprise of this kind would be technical education indeed.

We have now to enter upon the more special subjects of these lectures, and, for reasons before given, we begin with paper. Paper is one of those familiar objects about which the average man makes no inquiry. If it were suggested to him that his daily journal were printed on disintegrated deal boards the statement, even if credited, would not change his opinions about that journal in the slightest degree. On the other hand, I could name one or two men who carry technical sentiment to such a point of refinement that they would not even buy a journal which they knew to be printed on paper of which "mechanical wood pulp" or ground wood were the chief components. These are the extremes of indifference and scrupulousness between which we may endeavour to define the mean public opinion which certainly ought to prevail in regard to paper. We are considering for the moment writing and printing papers, which may be estimated to amount in this country to about two-thirds the total production. Going back in the history of the paper-making industry in this century, we notice two important epodes—1. The introduction of esparto pulp in 1852. 2. The introduction of "chemical" wood pulp in 1878. These pulps are the fibrous elements of the vegetable structures disintegrated and purified by chemical treatments. In this pure form they rank with bleached cotton and linen fibres as "celluloses." It is not many years since, in fact, as chemists, we are able to deferentiate these celluloses. At this date, however, we recognise three groups of the fibrous celluloses, of which the above-mentioned products are the typical representatives. Their characteristic differences may be conveniently set forth in tabular form as under.

	Cotton Cellulose Group.	Wood Cellulose Group.	Esparto Cellulose Group.
Carbon percentage	44·0	43·0	41-42
Loss of weight through boiling with dilute alkalies (after bleaching)	2-5	5-12	10-15
Action of oxidising agents	slight	pronounced	considerable
Colour reactions—			
(*a*) With aniline salts	none	faint yellow	red on boiling
(*b*) Phloroglucol and HCl.	none	brownish red	purple on boiling
Yield of furfural (per cent.)	0·2	2·0-4·0	12-14

These are important chemical distinctions. A little reflection will show that papers being required to resist mechanical wear and tear, the destructive action of atmospheric influences—air and moisture—and the attack of organisms, are to be valued in proportion to the chemical inertness of their fibre or cellulose components. The above table of differences will show that esparto cellulose differs from cotton in being a chemically active cellulose, and this activity is due to the presence of certain constituent groups which are identified and, in fact, measured, by the peculiar oily substance named furfural, which they yield on boiling with acids. To illustrate by a more familiar parallel. The metals are valuable in proportion as they resist the chemical action of atmospheric oxygen and water. Gold, silver, and copper represent three grades of such resistance, in respect to which our three groups of celluloses may be roughly compared to them. It may be noted that these three celluloses are drawn from three well-marked groups of the vegetable kingdom thus:—Cotton, flax, and the like from the dicotyledonous flowering plants; the wood celluloses chiefly from the needle bearing trees of the pine and fir class; esparto, straw and the like, from the equally important and familiar group of grasses or gramineæ which are flowering plants of the monocotyledonous order.

A classification of raw materials enforced by their position in the world of the chemist as of the botanist, surely has some meaning for the industrial world. As a matter of fact paper making in this country does admit of a very fair classification on these lines. Thus, there are first the "rag" paper mills, then the mills of which (chemical) wood-pulp is the staple, and lastly the esparto mills. To complete our classification we must introduce a fourth raw material, that is the ground work, or "mechanical" wood-pulp, mentioned incidentally in connection with journal paper. This substance is chemically as far removed from the "celluloses" as, to maintain our metallic parallel, iron is from copper. Not only is it a highly re-active substance giving directly brilliantly coloured compounds with aniline salts, phloroglucol, &c., but it is distinguished by being very rapidly attacked by atmospheric oxygen, undergoing a veritable combustion, the oxidation being attended by discolouration and disintegration. Papers of which this material is a component constitute the fourth class, and may be shortly indicated by the fourth letter of the alphabet, and moreover by a big D.

These papers are the very backbone of the newly created or rather newly recognised fourth estate. Here we notice a certain fitness. Much of the literature which fills the "something to read" necessity of the modern crowd is mechanical, wooden, and let us hope destined to perish. It is produced on the perishable basis of "mechanical wood." It may interest the audience at this juncture to introduce and apply to a few of our well known newspapers, a test which admits of a very rapid estimation of the proportion of this D material in a paper. We use in this test soluble compounds of the "coal-tar" bases, of which aniline is the prototype. Aniline itself gives a brilliant yellow colour, the result of a combination with a characteristic group in the wood substance, a group, which, for the information of the more curious, we may describe as of quinonic constitution. But a more pronounced colouration is that given by a near relative of aniline, a base which is known as dimethyl p. phenylene diamine. This base strikes a full red. The combination being, moreover, definitely or quantitatively related to the wood substance the depth of red produced is a measure of the proportion of wood present. It is easy, therefore, to make a comparative scale of these colours by tests applied to papers of known composition, *i.e.*, containing 10, 20 . . . . . 100 per cent. of mechanical pulp. The test has been thus simplified and organised by the discoverer of the re-action, the well-known chemist and paper expert, Dr. C. Wurster, that the active chemical is supplied in the form of test papers, which are moistened and squeezed between folds of the paper or pulp to be tested, and the resulting colours compared by a scale of tints, chromo-printed upon cards. This elegant test which we now apply to several of our well-known newspapers has not, in our opinion, received the attention it deserves. It has been for some 15 years before the technical public, and we venture on the assertion that a bottle of these test papers is an exceptional institution in the office or warehouse of our large buyers of papers.

As we are on the subject of tests applied to papers to determine the presence of their characteristic fibre-components, we may briefly note all those which are of sufficient simplicity to be readily applied.

Class D. Ground wood. Coloured directly by solutions of coal tar bases. Yellow with aniline; red with dimethyl p. phenyline diamine, cherry red with phloroglucol dissolved in hydrochloric acid.

Class C. Esparto and straw cellulose. Coloured rose red on boiling with dilute solutions of aniline salts. Stained yellow by caustic soda solution. On heating with phloroglucol and hydrochloric acid give deep red to purple colouration.

Class B. Wood celluloses. Faint yellowish colouration with aniline salts. Faint yellow with caustic soda.

Class A. Cotton and linen celluloses. No colour re-actions with re-agents mentioned.

These gradations of re-activity in what we may term special directions, are closely connected with re-activity in those directions which essentially determine the disintegration of cellulose fabrics of which papers are our first important group. A few words on the disintegrating agencies of the natural world and the four classes of raw materials in relation thereto.

1. Oxygen.—The atmospheric oxygen is an inactive form of the element not only by reason of its dilution by nitrogen but for that constitutional condition familiar to chemists as the "molecular state." In contradistinction to this are the atomic or active conditions in which it enters into combination, *i.e.*, oxidises

a number of substances inorganic or organic, upon which "free" oxygen is without action. For the purpose of this discussion the compounds known as ozone and hydrogen peroxide may be regarded as forms of active oxygen. For ascertaining the presence of active oxygen we have a "test paper," also devised by C. Wurster, a paper impregnated with the "coal tar" base, tetra methyl p. phenylene diamine, the elder brother of the "detective" previously described. This base is turned a deep blue by active oxygen, and again from the depth of colour produced, results an approximate estimate of the quantity. On testing papers containing mechanical wood pulp with the "tetra" paper we can show the presence of the active oxygen on the surface of the paper. Now by other tests it is easily shown that the wood substance is a highly oxidisable substance. We have here a paradox, a highly oxidising substance existing together with active oxygen. No doubt the latter is perpetually renewed, as fresh quantities of oxygen (previously rendered active) combine with the wood substance. These are obviously ideal conditions for the rapid disintegration of papers of the D class, and sufficiently accounts for their perishable nature. The celluloses of class C and in lesser degree of class B are oxidisable, very much more so than those of class A, very much less so than the "compound celluloses" (lignocelluloses) of class D. Their oxidation therefore is of a different character. A useful demonstration of the relative resistance to oxygen of the four classes of papers consists in treating them under equal conditions to the action of what may be considered a universal oxidant, viz., potassium permanganate in aqueous solution. This salt is of a deep purple colour in solution and in oxidising these organic substances, the manganic acid, which we may write as Mn_2O_7, passes into the lower oxide, Mn_2O_4, the 3 atoms of O going to the fibre substance. The lower oxide, of a brown colour, is deposited upon the fibre, staining it to a depth depending upon its relative oxidisability. The demonstration here given has a further application to the important industrial operation of "bleaching." All the celluloses —*i.e.*, of classes A, B, and C, in the course of their manufacture into paper undergo a bleaching treatment. After the boiling or pulping process, in which the raw materials are treated with alkaline solutions at high temperatures, the celluloses are obtained in an impure and discoloured condition. By the bleaching treatment the colouring matters are oxidised and converted into soluble compounds, which are removed, and a brilliantly white cellulose is obtained. For this bleaching action the permanganates are perhaps best adapted; they are not, however, used by the paper-maker. First, because they are relatively costly; and secondly, because the removal of the brown oxide, the by-product of the oxidation, involves a second chemical process, with attendant expense. But the agent invariably employed, which is the well-known "chloride of lime," may be regarded, as in the main, an oxidising agent. It is evident, therefore, from our demonstratron that the "bleaching" of coloured impurities is not limited to those impurities, but extends to the celluloses themselves. It is further to be borne in mind that the oxidised celluloses, or oxycelluloses, are much more oxidisable than the parent substances. Here, therefore, we see the cause of the special inferiority of the celluloses of class C and the inferiority of class B, considered in comparison with the rag celluloses of class A.

There is, moreover, a special cause at work tending to promote the oxidation of these celluloses when made into papers.

Papers of these classes are, for the most part, "sized"—*i.e.*, made suitably resistant to ink, by the addition to the pulp of ordinary resin. Of this process we shall speak in detail subsequently. At this point we have to notice an oxidising effect, due to the presence of resin in papers. Such papers always give the reactions of active oxygen, and this indicated an accelerated attack of the fibre substance by atmospheric oxygen.

2. The second disintegrating agency to which papers are normally subject, is that of water. To attempt an exposition of the actions of water upon "organic" substances such as the cellulose, starch, sugar series of compounds, we should require to expand this subsection of our subject to the dimensions of a text-book. Few phenomena are more remarkable than the profound changes determined by the insertion or withdrawal of so colourless and inert a substance as water. Thus the starches rapidly break down into sugars, and cotton may be equally rapidly converted into a microscopic dust as a result of such actions. These actions pushed to further extremes, and by the withdrawal of water (molecules) give rise to brown coloured products, very much more oxidisable than the original starch or cellulose. While in such actions water molecules alone are directly involved, they require the presence of an exciting substance: and

there are two groups of compounds which discharge this function; these are the acids and alkalis. Now the larger proportion of papers are finished with an acid reaction, the acidity being due to the alum used in the sizing operation. The acids are much more active than the alkalis in promoting or exciting the hydration changes, of which we have been speaking, in the complex carbohydrates. Hence we see that the conditions are present in the majority of ordinary printing and writing papers for chemical disintegration of this second order.

In certain cases, we may remark, a contribution of acids from the external atmosphere has to be reckoned with. Thus in the combustion of ordinary coal and coal gas, the sulphur impurity is burned to sulphur acids, and there are many conditions under which these corrosive products may contribute to the disintegration of papers. As a chemist, again, I may remind my fellow devotees that the atmosphere we work in is by no means always the "atmosphere" of the text-books, but frequently an atmosphere which puts our text-books through a severe trial of resistance. Publishers of chemical literature will please take note of these points, and especially of the conclusions which we shall subsequently draw as to the papers which they ought not to use for their publications.

3. The third important destructive agency of the natural world is the attack of living organisms. In certain parts of the world we know that paper is liable to the attack of "locomotive" organisms; but in our climate and under the conditions of our civilisation, we have only to reckon with organisms occupying the lowest positions in the scale of organisation; *i.e.*, the moulds and bacteria. That the fibrous components of paper are subject to the attack of these organisms, under certain conditions, is well known to all who handle them in large masses. But for this order of life certain conditions are necessary which are fortunately absent under the usual conditions of making, using, or storing paper, these are the presence of nitrogenous substances and a certain minimum of moisture which, expressed in ordinary language, would amount to distinct dampness.

In the making of certain papers, however, and these are papers of the very best grades, nitrogenous matter is added to the paper in the form of gelatine. This is used as a sizing agent.

The introduction of this substance adds at once a new danger. So it is only necessary to supply to these papers a little more than their normal hygroscopic moisture, and bacterial life is at once stimulated. Rapid growth ensues at the expense of the gelatine, and the "sizing" is broken down. This subject has been recently carefully investigated by Dr. W. J. Russell, F.R.S., in reference to a well-known defect in our standard drawing papers. His results are dealt with in an attractive communication to the *Magazine of Art*, January, 1896, page 98. Briefly summarised, they show that the more usual growths are micrococci. The evidence of their action, even when the growths are not visible, is seen on "washing" the paper as a preliminary to a water-colour drawing. At the infected spots the water at once penetrates and gives the paper a mottled appearance, with semi-transparent points or patches.

These results I am able to demonstrate through the kindness of Dr. Russell, who has contributed interesting specimens of papers showing these growths in a variety of stages. Dr. Russell discusses as a remedy the addition of antiseptics to the "size" before application, but admits that such remedies are attended by various disadvantages in addition to the uncertainty of their action.

We shall have something to say on this point in a subsequent lecture.

From this discussion it will appear that a classification of papers on the basis of their composition lies ready made, to hand. We venture to think that the facts once grasped (by an intelligent public), in their natural significance they will be rapidly acted upon: and action of this kind is more effectual in promoting "technical education" than many books and much speaking.

But a classification of papers based on chemical constants only is incomplete, for the obvious reason that paper is a fabric or structure and we have therefore to take into consideration its more important structural or mechanical properties. These are chiefly *strength*, measured by resistance to pulling, tearing, rubbing, and *elasticity*.

In the systematic measurement of these qualities, and the enforcing of such measurements as basis of values, our friends the Germans have gone ahead of us considerably. The individual observers to whose labours technical science is chiefly indebted for the important contribution of constants and the methods of determining them are Drs. Martens and Hersberg, of the Imperial Testing Station at Berlin, which institution has done a valuable work in putting these tests on a methodical basis and rendering available for industrial and commercial purposes, a classification based on these tests. It is unnecessary to describe the methods in detail, as they are fully dealt with in the text-books, and the excellent literature of the K. K. Versuchsanstalt. The following are the constants and an outline of the methods by which determined:—

(a.) Strength or Breaking Strain.—A strip of paper is exposed to strain or pull in a suitable machine, which records the tension applied until fracture is determined. As papers vary in thickness, and the medium weight which a paper will sustain is, of course, proportional to thickness, or rather to weight per square unit, it is necessary, in order that these breaking strains should be directly comparable, to reduce the numbers to a standard. It is also obvious that the breaking strain observed is proportional to the width of strip tested. A second reduction is therefore necessary. Both variables are eliminated by recording the test in terms of length of the paper itself, which could be unrolled in the free vertical direction before fracture would be determined. Papers again show a maximum and minimum strength in two directions at right angles to one another; in machine-made papers the maximum is in the direction of the run of the web on the machine; the minimum at right angles to this. Tests are, therefore, made in the two directions, and the strength of the paper expressed as a mean or average. The classification of papers on this basis is, of course, arbitrary. The official standards adopted by the Berlin Institution are six in number, viz., from 6,000 to 1,000 metres, *i.e.*, the highest class of papers will support a weight corresponding to a length of the paper of over 6,000 yards. It must be remembered that this quality only represents one aspect of the strength of a paper. Resistance to tearing or to a shearing strain is another important aspect. We have so far no means of measuring this by a recording instrument; but a tearing test is the common method of arriving at the strength of a paper; it is practised by buyers and makers, and the judgment based upon it is a matter of individual experience, and admits of no numerical expression.

(*b.*) *Elasticity* is measured in terms of the stretch or extension which accompanies strain and which reaches, of course, a maximum at the breaking point. The numbers in this case are more simple, being expressed in percentage, *i.e.*, increase in length of 100 units of length of the paper, stretched to the breaking point. Corresponding with the breaking strains the elasticity shows a decrease from 4·5 to 1·5 per cent.

(*c.*) *Resistance to Rubbing or Friction.*—This is an important quality of paper, but one which is not easily brought to a numerical expression. At the Berlin testing institution the rubbing test is applied by hand; a strip of paper suitably held in the two hands is rubbed upon itself across the thumbs; after say six rapid rubs in the two directions the strip is held to the light, fracture being observed by the appearance of tiny holes which appear as luminous points. The number of such treatments which the paper resists is taken as the measure of this order of strength. A test of this kind is, of course, of an arbitrary character. It furnishes important comparative indications of the qualities of papers; just as the ordinary tearing test with which paper makers and buyers are familiar. But it is impossible to institute an exact comparison between the results of say two observers. Attempts are being made to devise a machine test of this property; but in consideration of the several factors of the disintegration process, correlated with the several physical properties which go to make up the whole quality of resistance, it is doubtful whether such devices are of much practical, *i.e.*, scientific, value. We may apply a caution to ourselves in such matters. Science is supposed to eliminate superstition. But we must confess that we very readily lapse into that serene mental attitude. In nothing so readily as in over refinement. As an instance, "distilled water" is, of course, a very pure form of the familiar fluid. But it attacks glass, and certain kinds of glass very rapidly. After keeping in glass bottles it is often, therefore, a question whether it does not contain more matter in solution than an ordinary "tap-water," in districts, *e.g.*, Glasgow and Manchester, where the supply is of exceptional "purity." But students of chemistry are brought up rigidly on the distilled water superstition. This is a digression: but introduced for the purpose of showing that scientific precision is liable to tyrannise and become positive error, in the same way that the cherished mysteries of the empiric may obscure vision in the opposite direction.

To resume, we have now outlined the basis of a systematic classification of papers on the two-fold basis (1) of composition (pulp) and (2) of mechanical or physical properties. In the former we have four distinct classes, representing well-marked chemical differences, corresponding with sharp lines of demarcation, both industrial and physiological; in the latter we have to select on more arbitrary lines, and the selection of classes must be subordinated to convention and practical utility.

Before we draw our final conclusions on this matter, we must briefly note certain questions of minor importance. In regard to the composition of papers, we have alluded to the sizing processes, by which resistance to ink is imparted. Various practical tests of sizing are ordinarily employed by the paper maker and buyer. Such tests it would be difficult to bring to a uniform standard, impossible perhaps to express on a numerical basis. We must be satisfied with a rough division of sized papers into resistant, medium, and absorbent. We also note in the examination of papers the process employed, *i.e.*, whether sized in the pulp (engine sizing) or in the finished web or sheet (tub sizing); and also the agent or agents employed, *i.e.*, gelatin, rosin, or starch or mixtures of these.

An equally important side question is that of the proportion of inorganic or mineral matter present. Leaving out of consideration that which is normal to the celluloses or pulps, and that which is derived from the chemical processes incidental to their working up into paper, the sum of which is small, there remains the mineral matter added as "filling" or "loading." The proportion of "filling," which is, in the majority of cases, China clay, varies from 5 to 40 per cent. of the weight of the paper. From the point of view of the mechanical properties which we have been considering, the clay or other loading must be considered as an adulterant pure and simple: strength, elasticity, and resistance to friction are of course prejudiced by the dilution of the fibrous constituents by the foreign matter, not in direct, but in increasing proportion with increase in percentage of the latter. There are, it must be allowed, advantages of a certain order secured by the admixture of the loading matter. There is an increased density and opacity, and a finer surface is obtainable. Then, of course, the paper is cheapened by the introduction of an ingredient having only a fraction of the value of the pulp which it substitutes. It cannot be said that clay or other filling material contributes directly to the disintegration of papers under the influence of the causes previously discussed. Such are the more important pros and cons, and which we wish to emphasise to the general public. On the whole, it may be said that the practice is in many respects of doubtful utility, but it can only be regarded as mischievous in cases where the consumer is deceived.

Having thus enumerated the factors of value of papers, we may sum up and illustrate this discussion by an exhibition of papers of English make in the several classes, distinguishing them by a notation based upon this composition and properties as follows. Composition we indicate by the first four letters of the alphabet:—

A. Celluloses of the cotton class.

B. Celluloses from woods and lignocelluloses.

C. Celluloses from esparto and straw.

D. Lignocellulose or ground wood.

Mechanical properties by the Roman figures I.—VI., according to the German standard.

With a breaking strain of 2,000 m.—6,000 m.

On the basis of "loading," or added mineral matter, we may divide each class into, say, three sub-classes:—

1. Containing mineral matter less than 2 per cent.
2. Containing mineral matter more than 2 per cent., but less than 15 per cent.
3. Containing mineral matter more than 15 per cent.

Sizing might also be similarly expressed.

S_R = resistant, S_M = medium, S = soft or absorbent, S_W = the "waterleaf" or altogether unsized paper.

In the exhibit we include a selection of German normal papers, papers that is, conforming to the standards of the Imperial Testing Laboratory, and containing their class specification imprinted as a watermark on or in the paper itself. We need not reproduce their classification in detail, as should such a system come to be adopted in this country there are many and obvious reasons why we should have to select our own standards.

On such a classification as that which we have ventured to outline, as adapted to the trade of this country, specifications of papers would certainly be very much shortened and simplified.

Thus the better-class writing or "bank" paper might vary between A VI. S and A IV. S_m or B, V, S and B, IV, S_m; good printings would touch a limit at C III. S_m; low printings and news fall below this limit excepting as regards "clay" or "loading."

It must be understood that we do not lay any stress upon the attempt at a nomenclature; but we do emphasise the fact that a buyer of paper goes through a mathematical process in estimating the value of the material offered him, and he has his own mental symbols as the necessary "shorthand" for expressing the factors of value. Of course he does. Why, therefore, would he, as he most likely would, deny the impeachment, and regard the employment of symbols common to all as ridiculously impracticable. The answer may be left to be supplied from ordinary observation.

We must hasten on to the practical applications of this discussion. Of the now imposing list of investigations carried out at the Berlin testing station, and published in the Transactions of the Institution, we may select two as pointing the moral we wish to enforce.

1. A selection of 97 standard serial publications in various European languages, bound in book form, was investigated to determine the composition of the paper upon which these records, having a value for all time, are printed. The following was the results of the investigation, the classification being that of the German Institute:—

		Of the total 97 there appeared.
In Class 1.	Rag papers with less than 2 per cent. mineral matter	2
,, 2.	Mixtures of cotton, linen and chemical wood with less than 5 per cent. mineral matter	2
,, 3.	Pulp basis as in 2, but with 5 to 15 per cent. of mineral matter	31
,, 4.	Any composition inferior to the above and containing "mechanical wood"	62

The conclusion drawn from this investigation is that a large proportion of the literary and scientific work of the age is printed on an extremely perishable foundation; and it seems certain that if authors and the reading public were fully aware of this the practice of producing standard works on considerations of the merest commercial expediency would be radically dealt with. Even on the same low ground of merely commercial value it is unreasonable to prejudice the future value of a book on such a detail as the paper of which it is composed and a question of 1d. to 2d. a pound for this. As a more obvious illustration of this kind of commercial inexpediency, I may mention an incident from recent experience. I was shown a valuable set of actuaries' tables, published on one of our D papers, which after a year or two of office use was in such a condition that it had to be mounted with varnish, leaf by leaf upon cloth, at a cost of £3 10s.

Then again we see the transactions of our own learned societies published upon papers chosen on the basis of price and external appearance, and although to posterity our methods and nomenclature will not have their present day significance, we are not justified in an attempt at literary suicide.

Again, the public seem to have no basis of selection of papers for ordinary everyday use. Just as they will buy "linen" handkerchiefs at 2s. 6d. a dozen, and think them "cheap," so they will buy their 5-quire quantities of paper without any consideration as to whether China clay is "cheap" at 1s. per pound, or desirable on any consideration.

We are not going to say that the German testing station has as yet seriously educated the public in a classification of papers. They have in fact instituted an inquiry into this aspect of the trade, and as I reported upon this inquiry to the "Journal of the Soc. Chem. Ind." (January, 1896), I reproduce the abstract account of the results of the investigation.

Mith. K. K. Versuchsanstalt, 1894, p. 295; 1895, p. 219. *J. Soc. Chem. Ind.*, 1895, p. 48.

"The paper-testing work of the German Government Testing Institution at Charlottenburg has, as is well known, resulted in a systematic classification of papers according to composition and physical qualities, which classification, officially adopted, now regulates in an important and increasing degree the general practice of the manufacturing and wholesale trade. Whilst it has been easy to enforce the adoption of papers of specific composition in State and public offices, it is pointed out that the general public (in Germany) employ paper entirely at 'haphazard' even in writing documents of official and permanent value. With the view of forming a public opinion on this matter the Institution has undertaken an investigation of the practices prevailing in the retail selling and buying of papers. The scope of the enquiry may be outlined as follows:—Writing papers were bought at 35 of the leading stationers of Berlin, under recognised descriptions, such as good writing paper, best foolscap, best official note, good 'lasting' paper, etc., all implying the requirement of paper of high quality. They were bought in quantities of 10 to 12 sheets, and at the same time the price was obtained for the paper in quantities of 1,000 sheets. The papers where then analysed and classified according to the standards of the Institution The results are given in tabular form.

"At the same time also the question of selling price was investigated, the papers purchased being independently valued by three experts, the valuation being set out in tabular form, and a column giving the ratio of selling price to the mean figure calculated from the valuations.

"The tables given do not admit of abstraction, but the main results tabulated lead to the following conclusions:—Of the papers purchased as of 'lasting quality,' 17 per cent. only conform with such specification; of the remaining 83 per cent., 29 are papers which could be guaranteed for a few years 'life' under ordinary conditions of storage, and 54 are of the classes suitable for ephemeral purposes.

"The results of the investigation in reference to selling prices were even more surprising. They show unaccountable variations, the figures for the most part lying between from 2 to 80 per cent. in excess of the estimated 'fair' price.

"The Institution then carried out, some months later, a second investigation, which was an exact repetition of the first. The results, which are given in the 1895 vol., p. 222, substantially confirm those already obtained, *i.e.*, about 70 per cent. of the papers purchased were altogether inferior to the specification of the purchaser. It is noted also that three of the papers contained 'mechanical' wood pulp, and seven contained more than 15 per cent. of mineral (ash) constituents.

"Again, a similar investigation was carried out on the retail paper trade of Leipsic, and the results were closely similar to the above.

"The author (Herzberg) sums up the work of this self-appointed commission in the laconic remark: 'the probability of obtaining on demand a high-quality paper is, in the better class of stationers' shops in Berlin, about 1 in 5.'"

These are illustrations, chosen more or less at random, of the purely conventional basis of our uses of paper. It might be presumed that I have set out a case for progress, in the expectation or hope of a general recognition, first, that a movement towards the adoption of such constants regulating the production and consumption of paper would constitute "progress;" secondly, that whatever may be pleaded for the picturesque side of ignorance, there is no appeal from the spirit or law of the times we live in, which is that of intelligent conformity of industrial methods to the inexorable requirements of economic laws. I will anticipate criticism by disclaiming any such expectation. Prejudice is so well established with us in matters of industrial science that it cannot even recognise its own features when confronted with the mirror of fact, or if it does for the moment, it goes its way and straightway forgets what manner of individual it is. We labour away at the "technical education" of manual units, and train up the future masters of capital in the serene refuges of prejudice and mediæval perspectives. This is indeed picturesque, but in the meantime we have struck our colours to Germany, which leads in the modern scientific world, and, therefore, in industrial enterprise.

Miscellaneous.

EXTENSION OF BELGIAN VICINAL RAILWAYS.

Previous articles* have given particulars of the comprehensive scheme for endowing Belgium with vicinal or parish railways, and the results of their working, to the beginning of 1896; and this information is continued in the following article to the present year, the past year's working having given very favourable financial results. At the beginning of that period there were still two lines, both in the province of Luxemburg, and, indeed, in the wild and vaguely-defined district of the Ardennes—viz., one between Bourcey and Houffalize, and the other between Arlon and Ethe—which were worked to a loss, although that loss was diminishing. It is now very satisfactory to record that they have both made a profit, the former of 1,330 francs (£53 4s.), and the latter of 635 francs (£25 8s.), which sums will be devoted to clearing off the losses incurred on former years' working. At the beginning of the present year, the total loss sustained in working all the lines since the Société Nationale des Chemins de Fe Vicinaux commenced operations was reduced to 75,472 francs (£3,018 17s. 7½d.), while for meeting it, and also similar losses that may occur in future the general reserve fund is available, which has now reached the sum of 535,831 (£21,433), while the special reserve funds of individual lines have attained together the sum of 357,220 francs (£14,288).

Out of the 44 lines which have been in operation at least a year, 27 yield a dividend superior to the guaranteed interest on capital, seven others have paid a dividend of more than 3 per cent., and the remaining ten, one of more than 2½ per cent. The mean general rate of dividends has progressed from 2·65 per cent. in 1890, to 2·75, 2·76, 2·8, 2·9, and 2·98 successively, until it reached 3·08 per cent. las year. The mean of the general expenses is 3·8 pe cent. of the sums paid for making and stocking the lines. At the beginning of the present year 65 line were open for traffic, of which 45 showed more favourable results than at the beginning of last year 42 paying a higher dividend for 1896 than for 1895

The gross receipts for all the lines, and from al sources, amounted last year to 6,500,667 franc

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* See *Journal* of June 21st, 1896, and July 3rd, 1896.

(£260,026), and the expenses to 4,448,135 francs (£177,925), showing a profit of 2,052,532 francs (£82,101), the proportion of expenses to receipts being thus 68·43 per cent., against 69·3 per cent. in 1895. The 51 lines which carry both goods and passengers are classed, as regard their traffic last year, under the four following categories:—In the case of 34 lines, there was an increase in the receipts from both goods and passengers; and in that of two only was there an apparent, though not real, falling off in the receipts from both sources, special consignments of goods in 1895 not being continued in 1896. As regards the remaining lines, although the total receipts increased, there was a falling off as regards goods in the case of nine lines, and as regards passengers in that of six others.

No accidents whatever occurred last year to the *employés* working the trains; but four deaths are recorded of passengers who endeavoured to enter or leave a train in motion, or to pass from one carriage to another, while 24 deaths ensued to persons unconnected with the service, who endeavoured to cross the line in front of a passing train, or through drunkenness, deafness, or with the intention to commit suicide. The above figures show a proportion of 4·25 deaths, and 3·34 persons injured per million kilometres run over—a kilometre is roughly two-thirds of a mile. The number of kilometres run over last year was 6,594,187, against 6,149,262 in 1895, showing an increase of 6·75 per cent.

The Société Nationale had obtained the concessions of 75 lines, measuring 1,554 kilometres (965 miles), at the beginning of last year, during which it obtained 11 fresh concessions of lines, measuring together 104·5 kilometres (65 miles), bringing up the number of lines to 86, together 1,659 kilometres (1,031 miles) long. This number becomes, however, reduced to 77 on account of some of the concessions being extensions of existing lines, and also the retrocession to the Belgian State Railway administration of the Yvoir and Ciney line, which had been conceded to the Société Nationale. Of these 77 lines, measuring together 1,627·5 kilometres (1,011 miles), 66 are either entirely in operation, or partially so, for a collective length of 1,343·5 kilometres (834 miles), while all of the remaining 11 are practically under construction.

Since the beginning of the present year the Société Générale has obtained the further concession of four lines, measuring together 53 kilometres (33 miles), including that between Tervueren and Tirlemont, 41 kilometres (25 miles), to be opened in connection with this year's Brussels Exhibition, thus bringing up the total number of lines to 81, and the total length to 1,680 kilometres (1,043 miles), of which 1343·5 are in operation, and 336·8 under construction.

Moreover, the above figures do not include seven secondary lines, together 69 kilometres (42 miles) long, conceded to companies other than the Société Nationale, but the addition of which gives a total number of 86 vicinal or parish lines, having a united length of 1,748 kilometres (1,086 miles), and bearing the proportion of a little over 38 per cent. to that of the standard-gauge lines in the country, viz., 4,587 kilometres (2,850 miles).

THE DISCOVERY OF ZIRCONS IN TASMANIA.

Among the many valuable discoveries of late in the Colony of Tasmania, one which has created much interest in mining circles has recently been partially developed. It consists of a rare and unique deposit of zircons allied with other gems and rare earths. The gems found in this deposit are chiefly zircons, sapphires and cinnamon rubies. The first-named are found in large quantities, and in every variety of colour. Many of them have been cut and polished with very gratifying results, being hard and of good lustre. The United States Consul-General at Melbourne, who has lately been making an investigation into the circumstances of the discovery, says that the specific gravity of the zircon is 4·7, thus being heavier than the diamond, which is 3·75; its hardness, compared with the diamond is 7, the latter being 10. At the same time it is purely incandescent, being unaffected by the most intense heat, thus proving it to be of high commercial value for use in the manufacture of mantles for incandescent lights. It must be understood that the product of the gem, namely, oxide of zirconia, is used for the above purpose, not the gem itself. The composition of the pure zircon is 64 per cent. zirconia, and 36 per cent. silica. Analyses by Dr. W. H. Gaze, of Melbourne, of two samples of zircons from the above-mentioned deposit, give 63 per cent. and 64 per cent. of zirconia, thereby testifying as to the purity of the gem. The rarer earths, namely, lanthanuim, thorium, didymium, niobium, erbium, cerium, and chromium are all more or less present. The property which contains this rare deposit has been purchased by a Melbourne syndicate. It comprises an area of 105 acres, and is situated on the north-west coast of Tasmania, about midway between Emu Bay and Circular Head, and is easily accessible by road from either port. A large amount of work has been done in cutting races and forming dams for sluicing purposes, much labour being expended in removing the heavy timber from the creeks. The deposit of zircons is found in the bed and sides of the creeks, covering about a chain in width. From about 9 to 18 inches from the surface a gravelly wash is met with, averaging about eight inches in depth. This wash contains the zircons and other rare earths or minerals, and rests in a blue clay bed from one to two feet in thickness; then occurs a sandstone bar. The zircons and by-products are obtained by sluicing, the best results being secured by grading and concentrating by gravitation.

PATTERN DRAWING AND DESIGNING IN GERMANY.

Germany appears to have made very rapid progress in recent years in pattern drawing and designing. France has long held the first place in these particular branches, but Germany's rapid strides of late years bid fair to make her, in the near future, a most formidable rival of France in designing and pattern drawing for textile fabrics. The United States Consul at Glauchau says, in his last report, that thirty years ago designers or pattern sketchers were almost unknown in the German Empire. Since then, branching out from the German technical schools, pattern drawing has been pursued with most satisfactory results to the present day. Of late years the rush of young men to this branch of art designing and pattern drawing as a profession has extraordinarily increased. In the Royal Industrial Art School at Plauen, in Vogtland, which city is the centre of the embroidery and curtain industry, about two hundred young apprentices in designing annually finish their course. There are other large schools established in various parts of Germany, the principal ones being situated at Dresden, Berlin, and Crefeld. Three ways are open to every young man desiring to attain an education in pattern drawing and designing. He can either bind himself for a certain length of time as apprentice to an independent designer, who sells his pupils' sketches at discretion to manufacturers, or he enters the workshop of a manufacturer, who places the apprentice in charge of one of his draughtsmen until the apprentice becomes a qualified designer, when he gains promotion according to his own ability and originality of ideas; and lastly, a young applicant having means, may attend one of the academies of fine arts established by the State, where the highest proficiency is to be attained. Here pupils are thoroughly qualified according to the methods of the best teachers, whose instructions are most effectively and systematically carried out. Of late, various mnnicipalities have also spent large sums of money in establishing schools for pattern drawing. At the Academy of Fine Arts in Barmen, a department for the education of designers is about to be established by the State, and a prominent expert designer from Saxony, well skilled in the education of draughtsmen for the textile trade, has been especially engaged as principal teacher of the school. Schools which are modern, and which offer collections always accessible to apprentices and young designers, and keeping pace with the demands of art at the present time, are much appreciated in Germany. It was principally the schools, collections, and State workshops which Colbert established in the 17th century in France, and which are now distributed all over the country and abundantly sustained, that have brought the French textile industry up to its present standard of excellence. Pattern drawings from the Lyons Academy of Design, in their superior and artistic idea of the language of forms and flower designing, have taken first place among all designs, and have, by their beauty of conception and originality, largely influenced everywhere pattern designing for textiles, and designs for decorating.

EXTRACTION AND PREPARATION OF TALC.

Talc is extracted on a large scale from the granite mountain of St. Barthelemy, in the French Department of Arriège, about 32 kilometres (20 miles) from the main chain of the Pyrenees. The principal quarry, at Tremouin, is worked open-cast in three banks or terraces, each about 15 metres (49 feet) high. The best rock is of a bright white tint, and feels greasy to the touch when reduced to fine powder. The quarried rock is brought by a tramway to the end of the quarry in the Axiat Valley, and then by wagons for a distance of 19 kilometres (11 miles) to Luzenac, where 90-horse water-power is taken from the Arriège river. The mechanical preparation consists of drying in a rotary oven, breaking up small, grinding and sifting, the grinding being effected in mills with steel balls. The larger portion of the product, observes an Ingénieur des Arts et Manufactures, who has communicated these particulars to the *Chronique Industrielle*, is converted into powder, only a small portion being sent away in the rough state, or cut into pencils for writing on metals. Besides its use throughout most parts of Europe and America, in soap and paper-making. talc enters into the composition of wagon-axle grease, while it also serves as an insulator for electric conductors.

Obituary.

Sir A. Wollaston Franks, K.C.B., F.R.S., P.S.A.—This distinguished antiquary, who died on Friday, 21st May, at his house in Victoria-street, was elected a member of the Society of Arts in 1850, the years in which he acted as honorary secretary of the Exhibition of Ancient and Mediæval Art, organised by the Society—the first of its kind. He was born at Geneva in 1826, the eldest son of Captain F. Franks, R.N., and, on his family removing to Rome, he commenced his education in that city. He subsequently went to Eton, and graduated at Trinity College, Cambridge. From his early years he was attracted by the artistic side of mediæval archaiology, and in 1846 he contributed an essay on Palimpset Monumental Brasses to the publications of the Cambridge Antiquarian Society. He entered the Department of Antiquities in the British Museum in 1851, and in due course became Keeper of British and Mediæval Antiquities, the value of which department he greatly increased by the presentation of a large number of important objects. This office he quitted on attaining the age of 70. He was for many years Director of the Society of Antiquaries, and died President of that body.

Journal of the Society of Arts.

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FRIDAY, JUNE 25, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with Sec. 40 of the Society's Bye-laws:—

TREASURERS' STATEMENT OF RECEIPTS AND EXPENDITURE FOR THE YEAR ENDING MAY 31ST, 1897.

Dr.	£	s.	d.	£	s.	d
To Cash in hands of Messrs. Coutts and Co., 31st May, 1896	1,606	1	1			
Do. in hands of Secretary	27	6	1			
				1,633	7	2
,, Subscriptions	5,089	7	0			
,, Life compositions	273	0	0			
				5,362	7	0
,, Dividends and Interest				563	5	4
,, Ground Rents				667	11	6
,, Examination Fees and Programmes	1,160	10	2			
,, Donation to Examination Prize Fund:—						
Clothworkers' Company	20	0	0			
				1,180	10	2
,, Donations on account of International Congress on Technical Education				147	5	0
,, Conversazione, 1896 (sale of tickets)				63	15	0
,, Advertisements				604	5	9
,, Sales, &c.:—						
Cantor Lectures	10	14	7			
Fees for use of meeting-room	43	11	6			
Journal	129	5	6			
				183	11	7
				£10,405	18	6

Cr.	£	s.	d.	£	s.	d.
By House:—						
Rent, Rates, and Taxes	824	10	0			
Insurance, Gas, Coal, House expenses and charges incidental to meetings	249	16	2			
Repairs and Alterations	60	8	1			
				1,134	14	3
,, Office:—						
Salaries and Wages	2,090	18	7			
Stationery, Office Printing and Lithography	311	11	5			
Advertising	101	16	6			
Postage Stamps, Messengers' Fares, and Parcels	243	11	4			
				2,747	17	10
,, Library, Bookbinding, &c.				51	17	8
,, Conversazione (1896)				379	12	2
,, *Journal*, including Printing and Publishing				2,068	2	4
,, Advertisements (Agents and Printing)				415	4	11
,, Examinations				1,190	5	5
,, Medals:—						
Albert	24	7	6			
Society's	32	5	0			
				56	12	6
,, Mulready Prizes				31	5	0
,, E. London Exhibition Prizes				22	15	6
,, Fothergill Prize				28	4	0
,, Owen Jones Prizes				5	11	0
,, Drawing Society's Prizes				11	2	0
,, Cantor Lectures				218	15	0
,, Juvenile Lectures				20	10	7
,, Howard Lectures				100	0	0
,, Sections:—						
Applied Art	60	16	0			
Foreign and Colonial	60	0	0			
Indian	77	14	4			
				198	10	4
,, International Congress on Technical Education				24	19	0
,, Memorial Tablets				9	9	6
,, Committees (General Expenses)				12	12	3
				8,728	1	3
,, Cash in hands of Messrs. Coutts and Co., May 31st, 1897	1,651	6	8			
Do. in hands of Secretary	26	10	7			
				1,677	17	3
				£10,405	18	6

LIABILITIES.

	£	s.	d.	£	s.	d.
To Accounts due	392	13	1			
,, Examiners' Fees	476	16	0			
,, Examination Prizes and Medals	86	5	0			
,, Contributions to International Technical Congress	147	5	0			
,, Sections :—Applied Art, Foreign and Colonial, and Indian	180	0	0			
,, Accumulation under Trusts	428	8	2			
				1,711	7	3
Excess of Assets over Liabilities				21,082	13	4
				£22,794	0	7

ASSETS.

	£	s.	d.	£	s	d.
By Society's Funds invested as follows, and worth on 31st May, 1897 :—						
£1,542 12s. Consols	1,743	2	10			
£500 Canada 4 per Cent. Stock	540	0	0			
£500 South Australia 4 per Cent. Stock	535	0	0			
£530 10s. 1d. New South Wales 3½ per Cent. Stock	578	4	0			
£500 New South Wales 4 per Cent. Stock	610	0	0			
£217 Great Indian Peninsula Railway 4 per Cent. Debenture Stock	323	6	7			
£1,500 Queensland 4 per Cent. Bonds	1,635	0	0			
£500 Natal 4 per Cent. Stock	605	0	0			
Ground Rents (amount invested)	10,496	2	9			
New River Company Share (New)	425	10	0			
				17,491	6	2
,, Subscriptions of the year uncollected	504	0	0			
,, Arrears, estimated as recoverable	160	0	0			
				664	0	0
,, Property of the Society (Books, Pictures, &c.)				2,000	0	0
,, Advertisements on the Books, due, and in course of execution*				560	17	2
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1897				1,651	6	8
,, Do. on Deposit (interest on Trusts)				400	0	0
,, Do. in hands of Secretary				26	10	7
				£22,794	0	7

* A portion of this sum is subject to charges for printing.

INVESTMENTS, &C., STANDING IN THE NAME OF THE SOCIETY (INCLUDING TRUSTS AS BELOW).

	£	s.	d.
Ground Rents (amount of cash invested)	£17,669	4	0
Consols	3,146	12	3
Metropolitan Railway 4 per Cent. Perpetual Preference Stock	500	0	0
Bombay and Baroda Railway 5 per Cent. Guaranteed Stock	2,450	0	0
Canada 4 per Cent. Stock	923	0	0
South Australia 4 per Cent. Stock	605	16	0
New South Wales 3½ per Cent. Stock	530	10	1
New South Wales 4 per Cent. Stock	500	0	0
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170	0	0
Queensland 4 per Cent. Bonds	1,500	0	0
Natal 4 per Cent. Stock	500	0	0
New River Company (New) Share	100	0	0
Cash on Deposit with Messrs. Coutts and Co.	400	0	0

TRUST FUNDS INCLUDED IN THE ABOVE.

		£	s.	d.	
1.	Dr. Swiney's Bequest	£4,500	0	0	Invested in Ground-rents (costing £4,477 10 0), and chargeable with a sum of £200 once in five years.
2.	John Stock Trust	100	0	0	Consols, chargeable with the Award of a Medal.
3.	Benjamin Shaw Trust for Industrial Hygiene	133	6	8	,, ,, ,, of Interest as a Money Prize.
4.	North London Exhibition Trust	192	2	1	,, ,, ,, ,,
5.	Fothergill Trust	388	1	4	,, ,, ,, of a Medal.
6.	J. Murray, in aid of a Building Fund	54	18	0	,,
7.	Subscription to an Endowment Fund	562	2	2	,,
8.	Dr. Aldred's Bequest	173	10	0	,, chargeable with the Award of a Prize.
9.	Thomas Howard's Bequest	500	0	0	Metropolitan Railway 4 per Cent. Perpetual Preference Stock, chargeable with the Award of a Prize for an Essay.
10.	Dr. Cantor's Bequest	4,600	0	0	Invested in Bombay and Baroda Railway Stock (as above) and Ground-rents (costing £2,695 11 3). Interest applied to the Cantor Lectures.
11.	Owen Jones's Memorial Trust	423	0	0	Canada 4 per Cent. Stock, chargeable with the Award of Prizes to Art Students.
12.	Mulready Trust	105	16	0	South Australia 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
13.	Alfred Davis's Bequest	1,953	0	0	Great Indian Peninsular Railway 4 per Cent. Guaranteed Debenture Stock. Interest at the disposal of the Council for promoting the objects of the Society.
14.	Accumulated Interest on Trust Funds	400	0	0	On Deposit with Messrs. Coutts and Co.

The Assets, represented by Stock at the Bank of England, and Securities, Cash on Deposit, and Cash balance in hands of Messrs. Coutts and Co., as above set forth, have been duly verified.

OWEN ROBERTS, } *Treasurers.*
B. FRANCIS COBB, }

J. O. CHADWICK & CO., *Auditors.*

HENRY TRUEMAN WOOD, *Secretary.*

Society's House, Adelphi, 12th June, 1897.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Forty-Third Annual General Meeting for the purpose of receiving the Council's Report and the Treasurer's Statement of receipts, payments and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday, 30th June, at 4 p.m.

(By order of the Council),
HENRY TRUEMAN WOOD,
Secretary.

PRACTICAL EXAMINATIONS IN MUSIC.

The Practical Examinations in Vocal and Instrumental Music will be conducted by Mr. John Farmer, Balliol College, Oxford, and Director of the Harrow Music School, Examiner, and Mr. Ernest Walker, M.A., Mus.Bac., Oxon., and Mr. Burnham Horner (organ), Assistant Examiners, at the House of the Society, and will commence on Monday, 28th June.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d. each, on application to the Secretary.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The business of the Congress was continued on the 16th, 17th, and 18th instant. Meetings for the reading and discussion of papers were held on Wednesday, Thursday, and Friday. The meetings of Section A was held in the Great Room of the Society of Arts, and those of Section B in the Meeting Room of the London School of Economics, 10, Adelphi-terrace.

The concluding meeting of the Congress was held on the afternoon of Friday, the 18th June, at three o'clock, Major-General Sir Owen Tudor Burne, G.C.I.E., in the chair.

The CHAIRMAN said he should like to thank all those who had assisted to make this Congress a most valuable and useful one. The meetings had been attended by distinguished foreigners and visitors from the provinces. Our Colonial and Indian Empires had also been well represented. He wished also to thank those who had contributed so many able papers. He ventured to think that when the proceedings of the Conference were published they would be found of great value, not only to themselves, but also to the various Governments concerned. He then proposed that the following be appointed to form the Permanent Bureau of the Congress; and that the Central Office of the Congress be in Paris :—

The Duke of Devonshire, K.G., Lord President of the Council, President d'Honneur.

C. V. Brooks, of the Education Department (United States of America).

Eugène Rombaut, Inspecteur Général de l'Industrie et de l'Enseignement Industriel et Professionel, and M. Wauters, Inspecteur-Adjoiut de l'Enseignement Industriel et Professionel (Belgium).

Felix Martel, Inspecteur Général de l'Instruction Publique; P. Jacquemart, Inspecteur Général de l'Enseignement Technique; Léo Saignat, Président du Congrès, 1886, 1895; Jacques Siegfried, President of the Commercial Section of the Congress, 1895; J. Mesureur, President of the Industrial Section of the Congress, 1895; and Julien Manès, Directeur de l'École Superieure de Commerce et d'Industrie à Bordeaux, Secrétaire Général du Congrès, 1895 (France).

Boris Ovsianikoff, Attaché au Ministère de l'Instruction Publique, and Gregory Wilenskin, Attaché au Ministère des Finances (Russia).

Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., Chairman of Council, Society of Arts; Major-General Sir John F. D. Donnelly, K.C.B., Secretary, Science and Art Department; Professor William Garnett, Technical Education Board, London County Council; Sir Philip Magnus, City and Guilds of London Technical Institute, and Adviser to the London Polytechnic Council; Gilbert R. Redgrave, Chief Senior Inspector, Science and Art Department; Sir Owen Roberts, D.C.L., Treasurer Soc. of Arts, and Ceairman of the London Polytechnic Council; Sir Henry Trueman Wood, M.A., Secretary of the Society of Arts.

The resolution was seconded by M. Jacquemart, supported by Sir John Donnelly, and carried unanimously.

Monsieur Léo Saignat (President of the Congress 1895), speaking in French, said:—Permit me, before the close of this Congress, to thank you in the name of the French delegates for the reception which you have accorded to us. Those of us who know anything of the difficulties involved in the organisation of such a Congress as this, must have been struck with the satisfactory manner in which it has been conducted. This is the fourth International Congress in which I have taken part, and I shall carry back from it an exceedingly pleasant souvenir of my attendance at a Congress which has been devoted to a work of great public utility. May I also be permitted to express my approval and satisfaction at the establishment of a Permanent Bureau, which our Chairman has just proposed? I thank you again for the welcome you have accorded to us. British hospitality was known to us, and we knew that we should be well received, but the greeting and reception which we have experienced has passed all our expectations. We should be glad to think that an early opportunity would present itself to give you in France that welcome which you have so generously given to us here.

M. Wauters (one of the Belgian Government delegates), speaking also in French, wished to congratulate the Congress on having adopted the resolution to establish a Permanent Bureau in Paris, but he could not go from the Congress without expressing his thanks to General Sir Owen Tudor Burne, and those who had conducted the Congress, for the kind reception which had been accorded to the foreign delegates. They were happy and proud to be permitted to take part in its useful proceedings, and they were very sensible of the delicate attentions by which all the members of the Society of Arts had surrounded them. He desired to express to them the wish of M. Myssens, the Minister in Belgium, that the next Congress on Technical Education should meet at Brussels. He had heard that it was probable that it would meet in 1899 at St. Petersburg, and in 1900 in Paris, and he, therefore, continued to hope that it might be possible to select Brussels for the meeting of the Congress next year, when they would only be too pleased to have the opportunity of repaying the kindness and the welcome which they had received in England.

Mr. C. V. Brooks (American Government delegate), who had arrived from America too late to take any part in the Congress, said he had, nevertheless, seen enough of it to feel that their thanks were due to all those gentlemen who had worked so energetically in organising and conducting it.

Sir John Donnelly then proposed a vote of thanks to the foreign and colonial visitors to the Conference, and said that we had had many conferences and meetings in England on Technical Instruction, but he thought that the presence of thoroughly qualified gentlemen from abroad gave a wider field for thought, and ought to take the subject away from some of the minor details which are so apt to encumber it. He did not think anything would forward this subject so much as having the presence of men thoroughly qualified to speak on it, and who came with views formed in other countries.

The resolution was seconded by Sir Wm. Windeyer, and carried unanimously.

M. Jacquemart, acknowledging the resolution on behalf of the foreign delegates, proceeded to say that he was sure he would evoke a unanimous answer from the delegates when he asked them to accept the proposition which he had the honour to make, that a hearty vote of thanks should be given to the Chairman of the Congress, Sir Owen Tudor Burne. Everyone had been able to see with what distinction and amiability he had presided over the debates with which they had been engaged, and the foreign delegates especially were grateful to him for the cordiality of his welcome to them.

The resolution was carried unanimously.

The Chairman — Messieurs, je désire vous remercier infiniment des bonnes paroles que vous venez de nous addresser. Je vous assure de la part de la Société, qu' en nous honorant de leur présence, nos distingués confrères ètrangers ont rendu au Congrès un grand service. Non seulement ils nous ont aidé par leurs excellents discours, mais ils nous ont encouragé pour l'avenir; et, si, de notre part, nous avons été assez heureux d'avoir réussi à rendre agréable leur court séjour à Londres, c'est pour nous un vrai plaisir. Il faut ajouter que le discours lu, hier matin, par M. Siegfried dans la Section Commerciale en "Room B," e'tait un des meilleurs du Congrès.

The proceedings then terminated.

The reports of the discussions and the papers read at the several meetings will be printed in future numbers of the *Journal*, and will be published separately in pamphlet form.

Proceedings of the Society.

CANTOR LECTURES.

THE INDUSTRIAL USES OF CELLULOSE.

By C. F. Cross.

Lecture II.—Delivered February 22, 1897.

The manufacture of paper is one of those which change but little from age to age. This at least is true of the bulk of the production, or, to put it in another way, of the general practice of the art. It might be presumed, therefore, that the prevailing practice rests upon an exhaustive grasp of the principles underlying the art, and that the art has, therefore, attained to a position of terminal excellence. This, however, would be an unexpected achievement, in view of the fact that we are only just beginning to get an insight into the chemistry of the *matière première*. It would be conceded that as paper is substantially cellulose, and cellulose as an item in systematic chemistry is only just emerging from infancy, we have yet to look for advances in paper-making corresponding with increase of knowledge of its raw materials. We propose to deal practically with the application to paper-making of some recent advances in the scientific investigation of cellulose. The points we have to insist upon concern mainly the complex result known as "sizing." We say "complex" at the outset of the discussion, but it is perhaps necessary to advance some general preliminary proof of the complexity of the process, since it appears to be by no means generally recognised as a treatment involving several factors. It is usually assumed that the sizing of paper—that is, rendering it suitably resistant to ink (or more generally water and aqueous solutions)—consists in *adding* to it the necessary property. The bulk of papers are sized in the pulp by the addition of rosin, in the form of a soda compound or soap. The alkalinity of the soda compound is afterwards neutralised, usually by the addition of sulphate of alumina, which ensures the distribution of the rosin throughout the fibrous mass, in a form in which it exerts its normal water-resistant quality. This method of sizing is so striking in its effects, and the results are obtained with so small a proportion of the active agent—usually from 1·5 to 3 parts of rosin per 100 of paper—that it suggests the very simple view of the process which we have indicated. But, in such a view, other important contributory factors are left out of consideration. These are the various causes which determine the "closing" or compacting of the web, the conversion of the mass of pulp into the texture or fabric familiar to us as finished paper. Of first importance of course is the condition of the pulp in the final state of preparation before making, which introduces at once the whole question of the paper-making qualities of the various celluloses or fibres. So far as this is a mechanical or structural question, so far that is as paper varies with the form and dimensions of the ultimate paper-making unit, its elements are fully grasped by every experienced paper-maker. We presume also that this common experience is reflected or expressed in the scale of values of the staple raw materials; but we should like to ask the question whether even in this mechanical side of the matter the paper-maker does not owe a larger debt to Nature than he is aware of? I will suggest to a paper-maker, to use a lawyer's expression, that he would be considerably puzzled to know how to take advantage of a lignified fibre, having the dimensions of the celluloses of class A, or a monocotyledonous raw material giving a resistant cellulose but of the form and dimensions of the esparto fibre. That he does not meet with these problems is due not so much to his exhaustive grasp of the probabilities, as to the natural causes dealt with in the previous lecture, which limit the number of available fibres, and which determine the correlation of characteristics of form and structure with those of chemical composition. As a practical illustration of the force of such criticisms, we may recall the history of the introduction of new materials, such as esparto and wood-cellulose. How were these fibres reduced from the wild to the "domesticated" state in which they are at present known and handled? Not without much heart-breaking experience, which, unfortunately for the technology of the subject, is not recorded in detail. What we do know of such a record of failures, however, we should not forget, as they measure progress, and also keep us in mind of the large probable advances still before us. In regard to the present discussion they confirm the view that in the industrial arts we prefer to struggle into perfection rather by the laboured process of practical adjustments than on the lines of scientific dissection of causes.

But we have already admitted that paper-making is, on the mechanical side, a very perfect art; we have merely introduced these adverse reflections by way of showing that even this perfection is measured quite as much by the "providential" limitations of Nature, as by the positive achievements of human pioneers.

When we come to deal with the chemical factors of the paper-making process we find we have much more to learn, a conclusion which we shall be able to justify by recent experiences.

Coming into the knowledge as we did in 1892 of a simple method of dissolving the celluloses, a method, moreover, which occasions no essential change in chemical constitution, it occurred to us that the solution should find a use in the engine-sizing of pulps. The solution is known as "Viscose;" it is prepared by the successive treatment of the celluloses—(1) with an alkaline hydrate, *e.g.*, caustic soda; (2) with carbon bisulphide. By simple synthesis in these two stages the cellulose is converted into sulpho-carbonate. As this product has been the subject of a number of communications to technical journals, and will be more fully dealt with in our next lecture, we shall assume a general acquaintance with its properties. All that is necessary to bear in mind at the moment is that it is easily decomposed, with reversion of the cellulose to the insoluble condition. Separated thus from the solution as a product of decomposition, it is a structureless, gelatinous mass, retaining a high proportion of water of hydration; this it loses gradually or rapidly according to the temperature. Viscose therefore added to the engine and suitably decomposed has the effect of coating the fibres with gelatinous hydrates of cellulose. The effect is marked by the increased "wetness" of the pulp, *i.e.*, increased capacity for holding water; the water is longer retained in the passage of the pulp over the wire of the machine, a condition which favours the interlacing of the fibres together. Under the action of the press rolls, the interlocking of the fibres is favoured by the presence of the gelatinous substance, which may be regarded as a species of cement; and in the final processes of drying, the shrinkage of the gelatinous cellulose which accompanies dehydration further aids the process of compacting the sheet.

Effects of this order have been long recognised as a valuable auxiliary to the paper-making process, and various substances have been, and are, used for such purposes. Starch is the most common; some nitrogenous colloids are also used, notably casein and gelatin, suitably precipitated or rendered insoluble; and the sizing function of alum, which is almost invariably used in quantity, is in part due to the properties of the colloid oxide, the hydrated alumina, which it yields as a product of decomposition by the more basic oxides present in the pulp or added to the engine.

It should be noted also that in the sizing of paper in the sheet or web—tub-sizing as it is called—colloid substances in solution, chiefly gelatin, are used for the same purpose, *i.e.*, coating the fibres and filling the interstices of the web with a structureless, homogeneous substance, the surface tension of which antagonises the capillarity of the fibre of the paper, and thus largely reduces its porosity.

These effects must be separated altogether from those determined by the addition of a substance like rosin. Rosin is a water-repellent substance: the colloid substances of which we have been speaking have a large and specific capacity for absorbing water. The former cannot contribute to the closing and contracting of the sheet: but this largely depends upon the presence of the latter. We will continue our discussion of these factors before reverting to the theory and practice of rosin sizing, which we shall find is considerably affected by assigning a due value to the function of the gelatinous colloids present in the pulps and added in the process of manufacture.

In sizing with viscose it is found that while the mechanical resistance of the finished paper may be increased from 20 to 80 per cent. compared with paper made in the ordinary way from the same materials, the increase of strength measured *after wetting* is very much greater. We will demonstrate this by comparative tests of tissue papers, such as used for cigarettes, weighing only nine grains per square metre, one sized with viscose, the other in the ordinary way. Paper-makers will recognise this test as the most severe, as sizing effects are produced with increasing ratio of difficulty as the substance of the paper diminishes. Similar effects are produced over a wide range of papers, and we may take it as proved that the paper-making qualities of fibres are generally much increased by the presence of cellulose in the gelatinous or hydrated form. Viscose, owing to the low price at which it can be produced, to the special condition of the cellulose in solution, and the ease with which it can be deposited upon the fibres without prejudicing their manipulation upon the paper machine, enables us to practically demonstrate, and, in fact, in a measure, control a quality in the fibrous celluloses which has hitherto been somewhat vaguely recognised.*

If now we examine into the paper-making qualities of the staple fibre, and the methods by which they are handled, we shall find that these considerations supply some explanations worthy of consideration by practical men.

1. As we descend in the scale of celluloses from A to C the length of the fibre diminishes, but the tendency to form cellulose hydrates increases. The beating process increases the degree of hydration of the fibre substance. The long beating of the rag celluloses, in comparison with esparto and straw, appears, on a first view, to be required merely in proportion to their superior length and "strength." It is, however, attended by effects of hydration of the cellulose, and the experienced beater man aims at a certain standard of hydration or "wetness," though his judgments usually express themselves in terms of length of fibre.

We see that owing to the play of these two factors, and their natural self-adjustment, an average of paper-making quality is secured over the average of staple fibres.

2. The "lowest" grade of cellulose ordinarily employed in paper-making is straw cellulose. The hydration capacity of this cellulose is a maximum ; its use in practice is recognised to depend upon its adding "wetness" on the wire, and, consequently, the quality of hardness and "rattle" to the finished paper.

3. Mechanical wood pulp is deficient in hydration capacity ; the reasons for this are well known to the chemist, just as the reasons for the opposite tendencies of straw cellulose are also seen in its chemical constitution.

The addition of a sizing agent, such as viscose, might be expected to show the greatest advantage, therefore, in papers where ground wood is used in large proportion ; experience confirms this conclusion.

4. It should be borne in mind that if it is an important matter in practice to ensure the presence of these colloidal cellulose hydrates, the paper-maker should be aware of all the circumstances which tend to produce them, and equally of those which tend in the opposite direction. All the ordinary alkaline treatments of the raw materials contribute to their formation ; high temperatures and an acid reaction in the after processes tend to break them down. Hence it is bad practice to use the back water from the paper machine in furnishing the beaters, as we have seen done in some mills, and excess of alum is especially to be avoided. Probably also the vexed question as between hard and soft waters in paper-making might be effectually compromised in regard to the question under discussion by providing soft water throughout the preparation processes—*i.e.*, up to the machine—and hard water upon the machine, for the reason that lime salts tend to combine with these cellulose hydrates, and in combining to deprive them of their special characteristics.

For the same reason the bleaching process, as ordinarily practised, has to be reckoned with as changing the paper-making properties of the celluloses. We have never seen, for instance, sodium hypochlorite used in place of the usual "chloride of lime" in a paper works, although in textile bleaches the preference is common. The paper-maker would naturally ask what compensation in result he would get from the added cost of making the soda bleach, viz., the value of about three-fifths the weight of the bleaching powder of soda ash ? Two probable results might be mentioned : one is that in certain cases a soda bleach is more economical in expenditure of the active bleaching compound ; the second is that the condition of the celluloses after a "soda bleach" will be found to favour the "hydration" action of the beating. As a compromise it might also be noted that the addition of sulphate of soda to bleaching liquor gives sodium hypochlorite with a precipitate of calcium sulphate. The sulphate having only about one-third the value of the carbonate of soda does not add much to the cost of the liquor ; and this variation of the ordinary process is the better worth bearing in mind.

We have now to consider what "sizing" action in the ordinary sense is attributable to the colloid hydrates. I may mention as direct evidence on this point, that in connection with my investigation of raw materials at the exhibition of 1886, a paper was made from an exhibit of banana refuse. The paper made from the fibre, prepared by boiling in alkali, washing and bleaching, but without addition of sizing materials, was of a remarkable character, semi-transparent and very tough : moreover, it was resistant to ink. This result was due to the high degree of hydration of the resultant celluloses. Similarly, if we dry down viscose on a glass surface we obtain a gelatinous film. On washing to remove the alkaline by-products we obtain a transparent skin or parchment-like material, which is a pure cellulose in its structureless form. This too is ink-resisting, in the sense that the finest or thickest lines drawn on it with ink "dry" with perfect sharpness. The ink penetrates the surface, but vertically, downwards.

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* It would be out of place to discuss this matter into more minute details. We have perhaps said sufficient to afford a basis of observation to those who have never given it any direct consideration. To those who wish to follow it up by experiment we should suggest (1) observations of the breaking strains of papers when wet ; (2) careful comparisons of this quality in papers made from the staple raw materials ; (3) making sheets of paper from beaten pulp treated under various conditions.

To come to a more practical demonstration: it is found that in engine-sizing with viscose, in certain cases a "hard sizing" effect is produced; in the majority of cases, however, it is found that to give the normal resistance to ink, the addition of rosin is necessary, but the quantity is reduced from half to one-third the usual. We may explain this action by effects in two directions. (1) The fibres are coated with the gelatinous hydrated cellulose, which communicates a certain resistance to water; (2) the rosin is therefore distributed over a larger surface and is proportionately more effective.

These considerations lead to a modification of the prevailing "theory" of rosin sizing. Dr. Wurster's well-known monograph on this subject (Bull. Soc. Ind., Mulhouse, 1878) threw a very important light on this long-established matter. Prior to this exhaustive and lucid criticism of the subject it was generally held that the actual sizing substance in the paper was a resinate of alumina, resulting from decomposition of the soluble soda-rosin compounds, by the sulphate of alumina subsequently added in the engine. Wurster showed that the resinate of alumina was more or less mythical, that the rosin-acids themselves are the sizing agents, with the alumina, resulting from decomposition of the alum or sulphate of alumina, acting as an auxiliary, much in the same way as the colloid cellulose hydrates. To prove this view Wurster relies upon the actual evidence of the presence of "free rosin" in ordinary hard-sized papers. A series of papers exhausted by solvents of rosin (as of resinates of alumina) showed losses varying from 2·8 to 4·7 per cent.; an estimation of the total ash in the papers thus exhausted showed only fractional differences (0·05 to 0·10 less per cent.) from the ash of the original paper, showing that alumina was not dissolved away.

Since the date of publication of these researches much work has been done upon the dissociation of salts in dilute solution; and we may apply these results to the consideration of the actual mechanism of "sizing" with soda-rosin compounds. We may more particularly avail ourselves of the investigations of C. R. A. Wright, the results of which are published in his Cantor lectures, 1885. [See also "Oils, Fats, Waxes," p. 487.] He showed that the soda salts of the fat and rosin acids are at once dissociated by water into free soda and fat acid.

In the beater, as we know, the proportion of water to pulp is 20-30 to 1. On adding resinate of soda, calculated to say 3 per cent. rosin on the pulp, it is diluted to a $\frac{3}{20-30}$ solution. A 0·1 per cent. solution of the soda resinate will undergo considerable dissociation. The decomposition is increased by the tendency of the celluloses themselves to combine with soda. It is further aided by the lime salts always present, and by carbonic acid or bicarbonate usually also present. Probably, therefore, before the addition of alum the soda-rosin compound is decomposed and the rosin acids are distributed over the surface of the fibre, the alum neutralising the soda and completing the liberation of the rosin acids.

So much for the theory of these further causes, which is confirmed by a consideration of the mechanism of rosin sizing. Now as to the practice. Based upon his experimental results, Wurster concluded that the ideal form of a rosin size was that in which as little soda was used, as is consistent with a perfect distribution of the rosin. When the proportion of soda is the full equivalent of the rosin acids, the diluted size is a transparent solution.

On the other hand, with a much less proportion, rosin can be reduced to a homogeneous mixture, containing "free rosin." Dissolved in rosin soap, on dilution the free rosin constitutes a perfect emulsion, and is, therefore, distributed in a state of maximum solid subdivision throughout the mass of pulp.

Now, we do not follow Wurster in his contention that this is the ideal condition for sizing. This is the ultimate condition (in the paper), but it must be admitted that perfect solution is the condition of maximum sub-division, and for perfect distribution it would be better to add the solution to the pulp, and, indeed, to prevent emulsification, by dissociation, until the solution is incorporated as such with the pulp. This, in fact, is the condition which obtains in sizing with viscose and rosin jointly, the alkali contained in the former will prevent dissociation of the soda resinate by supplying excess of soda. The fact that we are able to produce ink-resisting papers, with one-half to one-third the usual amount of rosin, shows that the distribution of the rosin is certainly not prejudiced by the conditions of sizing, which are certainly the very opposite of those of the present usual practice, *i.e.*, of using a very "acid" rosin size.

The chief advantage of this practice appears to us to consist in the very obvious economy of alum. The limit of its advantage appear to us to be reached in dealing with pulps which are beaten very "free;" pulps, on the other hand, which are beaten for a long time, or from their composition contain a high proportion of hydrated or gelatinous celluloses, are certainly much more economically sized with the "acid" sizes in both senses of the term. These conclusions are drawn, it will be noted, from practical experience in two very oppostie directions.

As this discussion as been necessarily somewhat long, it may be as well to sum up the point which has been dealt with.

1. In the sizing of papers the ink or water-resisting effect is an added quality.

2. The closing or compacting of the sheet is due to the presence of gelatinous hydrates. Starch or alumina (hydrate) contribute in this direction, but their adhesion to the fibres is imperfect. Cellulose, added in the form of its soluble compounds, is much superior, owing to the fact that it retains its structural features in drying or dehydration; starch and alumina, on the other hand, tending to break up and to become mere filling agents.

3. The effect of long beating is to add "wetness" to a pulp by hydrating the celluloses of the fibres.

4. The gelatinous hydrates assist in the distribution of the compounds added to give water-resistant effects, and, therefore, to increase their efficiency.

5. The modern practice of using very "acid" sizes is economical by reason of lessening the quantity of alum necessary to be used. It is on all ground to be recommended when dealing with "wet" pulps, but may prove to be relatively inefficient when pulps are only a short time in the beater, or for other reasons are deficient in wetness.

To complete this demonstration we exhibit a number of viscose-sized papers, some containing viscose only, some viscose and rosin.

The general effects of the viscose sizing are now proved to be, by results obtained over a wide geographical area—(1) increase of strength from 40 to 80 per cent; (2) reduction of rosin necessary to complete the hard-sizing effect from one-half to one-third the usual proportion. The proportions of viscose (cellulose) necessary for these effects vary from 1 to 8 per cent. of the weight of furnish.

We have now to deal with a number of special developments in the textile industries which mark the period of which I have personal experience. It will be allowed that in the year 1880, notwithstanding the then advanced condition of many of the cellulose industries, the science of the subject was in a very nebulous condition. In the subsequent period there has been a substantial advance, and having taken an active part in the work by which the advance has been realised, I propose to note in historical sequence the industrial developments in the working out of which I have been practically engaged. I make this selection for the obvious reason that these are the matters upon which I am best qualified to speak.

1878-81.—*Jute Bleaching and Printing.*—The chief employment of jute is for the lowest class of textiles, such as sacking, and wrapping, and baling cloths, and for the lowest grades of floor-cloths, in which it plays the part of a foundation merely, or carrier for the linseed oil mixture which makes up the ornamental element. But though playing the Cinderella part amongst fibres, it is known to be capable of better things. To take a higher place, however, it required more refined processes of mechanical preparation, in order to give a yarn with something like uniformity and of finer grade, and the yarn, or the cloth woven from it, must undergo the purification of a chemical bleaching treatment. The practical limits met with in spinning jute to fine numbers we have previously alluded to. We merely mention that in the line-spinning system very satisfactory yarns are obtained, in the coarser counts, however, which weave into ornamental fabrics.

In bleaching such fabrics, however, we have at once to reckon with the structural and chemical peculiarities of the fibre, which are the very antithesis of the high-grade textile fibres. The industry which was established in Barrow-in-Furness in 1876, was a manufacture on these lines into ornamental furniture cloths, printed in suitable "conventional" designs by the ordinary methods of the calico printer. The cloth was bleached by a simple method consisting of—(1) an alkaline scour; (2) a treatment with bleaching powder, *i.e.*, solution of calcium hypochlorite.

But the special characteristics of the fibre substance were not reckoned with. This we know to contain an "unsaturated" component of a benzenoid character and the action of bleaching powder upon such a component is not an *oxidation*, as is the case with the celluloses, but a *chlorination*—a combination of chlorine as such with the fibre substance. Such chlorine compounds remain in the cloth, resisting the after processes of washing: and there they work destruction.

After bleaching, the cloth was printed by the methods used for cotton goods, the colours being fixed by exposing the cloth to the action of steam in a closed chamber. By this treatment the chlorinated fibre compounds were decomposed: hydrochloric acid was set free and wholesale "tendering" resulted. The tendering or rotting of the fabrics was, as the chemist will foresee, capricious in its incidence. The chlorination of the jute was sometimes local, sometimes general. Thus, when the goods were imperfectly washed from the scouring alkali, when the solution of bleaching powder was "basic" from other causes, when temperatures of bleaching were low, causes were contributing to reduce chlorination and favour oxidation with alkaline hydrolysis.

In face of disastrous results which at once began to undermine a lucrative and attractive development, it was a little late to call in the aid of science. It was a little "severe" on the chemist when employed to find that the foundations of the house had to be dug with the upper storeys already falling in. It was literally a question of attacking the fundamental question of the constitution of the fibre substance. This solved in general terms, it was easy, not only to devise appropriate remedies, but to carry the bleaching of the fibre to a much higher grade of colour and finish, and, moreover, to maintain both under the severe steaming treatment of the printer. But in the meantime it had become as difficult to get 1s. a yard for the much improved fabric as it had been easy to get 2s. 6d. for the inferior forerunner. To put it briefly, the business was ruined. The world, of course, would see nothing but the ruin. It must be noted, however, that technology benefited by the incidents of the ruin, in getting sound practice in the bleaching of jute goods; and as to the contributions to science upon which the improved practice is based, the reader can satisfy himself of their substantial character by reference to "Trans. Chem. Soc." and "Bull. Soc. Ind.," Mulhouse, 1880-3.

This early experience of mine has, I am sorry to say, been so often repeated that one is tempted to generalise, and to regard the natural order of technical developments as consisting in the following stages:—(1) Discovery by the empiric; (2) partial and unmatured exploitation by capitalists ignorant of scientific principles; (3) failure and exposure of defects referred to scientific investigation; (4) a sound technical departure by which the industrial world and science benefits, at the expense of the pioneers.

I may point out more expressly that the investigation of the jute fibre led to the recognition, in the lignocelluloses generally, of the special molecular group of quinonic constitution; the chlorides which they form, by direct combination with chlorine, are quinone chlorides of definite characteristics. The constitution of these groups, to which the special distinctions of the lignocelluloses from the celluloses are exclusively due, fully explain the reactions with the p. diamine base dealt with in our last lecture. In his original publications, Wurster had overlooked the publications containing an account of these researches, and he was inclined to attribute the reaction to external causes, such as active oxygen present on the surface of the lignocelluloses. It is now, however, clear that it is a definite and quantitative synthesis of a colouring matter, as between the p. diamine and the quinonic group of the lignocellulose.

1884-7.—*Cotton Bleaching.—The Mather Kier.*—This system of bleaching, identified with the firm of Mather and Platt, of Manchester, originated in the investigations of my partner and myself, and a brief notion of its early history will be found to involve some interesting technological questions. It may be mentioned at the outset that the central feature of the bleaching system is a treatment of the cloth or yarn with caustic soda solution at high temperatures. This, in fact, is substantially the *bleaching* process, for a cotton and linen bleach consists essentially in the *isolation of a pure cellulose*. The bleaching treatment proper, or rather as ordinarily understood, consists in the removal, by oxidation of residues of coloured compounds surviving the preceding treatment. The percentage of substances removed in this alkaline oxidation is only a small fraction of the total non-cellulose constitutents of the raw cotton; by far the larger proportion of these are attacked and removed by the process of alkaline saponification.

It was the failure to grasp these ideas, now established by long practice, which led to various earlier inventions in varying the ordinary method of "bleaching" or whitening by means of the hypochlorites. One of these, the invention of Thompson, consisted in impregnating the material with weak solutions of bleaching powder, drawing off the solution from the goods contained in a closed vesssel or kier, and then introducing carbonic acid gas. It is now well known that this does result in an intensification of the action of the calcium hypochlorite, or solution of bleaching powder. Thompson's invention was taken up by a limited company and first put in operation at the works of Messrs. Ainsworth, Halliwell, near Bolton. Simultaneously with the empirical development, a chemist at Rouen, the late Georges Witz, was investigating the reaction from the point of view of its action upon the cellulose itself. He showed that the cellulose is oxidised under these circumstances to an oxycellulose, which is especially distinguished from cellulose by its "affinities" for colouring matters. These results are now well known to all technologists, and we need only mention the references to the original communications on the subject [Bull. Rouen, 10 and 11 J. Soc. Chem. Ind., 1884], noting that in a still more recent contribution it has been shown that, when carried to its limit, the oxidation of the cellulose gives a product approximating to the composition represented by the formula $C_6 H_{10} O_6$.

Mr. William Mather becoming acquainted with the Thompson invention (at the same time that we were engaged as chemists to the company), he exposed the technical weakness of a closed kier method of treating the cloth, and proposed to make the process the basis of a continuous system of "chemieking." He devised a chemieking chamber, the first model of which was erected at the Salford Iron Works, in October, 1884. It was proved by experiment that the bleaching effect was realisable with great rapidity; but, on the other hand, it was evident that the limit of action was determined by the previous alkaline treatment to which the cloth had been subjected. It, therefore, was important to reduce this treatment to a single operation. From October, 1884, to January, 1885, the investigations of this problem was left in my hands. It was evident that for a drastic saponification of the non-cellulose constituents of the cotton (together with the seed residues or motes), caustic soda was necessary in place of the ordinary treatments with lime and soda ash in successive operations. It was soon demonstrated by crude experiments in extemporised apparatus, that the desired effect was readily obtainable and without injury to the cloth; moreover, after a "steaming" treatment of the cloth, impregnated with a 1 per cent. solution of caustic soda, followed by washing, the cloth was readily whitened by a passage through the carbonic acid chemieking chamber.

The difficult problem of carrying out the treatment upon large masses of cloth was next investigated, with the co-operation of Mr. E. Manby, the manager of the Halliwell works. The final stage in the evolution of the matter was Mr. Mather's brilliant invention of the steamer-kier, with its movable waggons, and its extremely simple methods of "circulating" the caustic liquor in the closed kier. It is well known that by improvements in detail, rapidly perfected, the defects in the earliest forms of the apparatus were soon overcome; but it is sufficient testimony to the grasp and foresight of the inventor that the apparatus of to-day differs from the original kier only in comparatively unimportant details. It is, moreover, sufficient evidence of the importance of this invention to note that over 150 of these kiers are now in operation in all parts of the world, and that the capacity of these kiers amounts to an output of 4,000 tons of cotton (and flax) goods weekly.

The complementary process of rapid chemicking on the Mather-Thompson principle must at this date be dismissed as having little more than a historical interest. It was worked for some time at the Halliwell works on a "continuous" machine, resembling an open soaping range; but the perfection of the process of alkali treatment resulted in a formal and practical proof that this is in effect the essence of cotton bleaching, the bleaching treatment proper, measured in terms of "chemical work," being relatively unimportant.

This conclusion follows more explicitly from a consideration of the consumption of chemicals in bleaching cotton goods. Whether on the Mather system, or on the system which it displaces, the "drugs" per ton of cloth may be estimated at 10s. to 13s.; the allowance for bleaching powder—an item of 24lb. to 36lb. weight—amounts to only about one-fifth. There is no great margin in this direction to encourage the irresponsible inventor, and those who dream of "fortunes" to be made in improved methods of carrying out the whitening operation, indulge a false perspective of values.

While on the subject of costs, we may briefly note the items of labour and coal. The former again is small on either system, 7s. per ton being a fair average estimate. In coal, on the other hand, the Mather system can claim an important economy for obvious reasons. The construction of the steamer-kier enables us to operate with a minimum volume of solution, not more than 3·4 times the weight of cloth. In open-kier boiling, and generally in cases where there is no forced circulation of the boiling liquid, the minimum weight of liquid to secure uniform boiling is 7·10 times the weight of the goods. Comparing one operation on the two systems, the steamer-kier effects a proportionate economy. But on this system the alkali treatment is reduced to a single operation; in other systems the cloth may be boiled from two to four hours, with proportionate consumption of coal.

On the whole estimate for drugs, steam, and labour, an economy of 5s.—15s. per ton of goods treated may be claimed for the matter of system.

Water, in certain cases, is an important item of cost; in such cases the Mather system has more prominent claims, as it certainly reduces the consumption of water to a minimum.

The Rhea Industry.—To write the past history of enterprise in the "nettle fibres" would challenge the powers of our writers of romance. To do it justice, an author would need to bring to his task a full sense of the picturesque in men and things, and a little—very little—technical knowledge of the subject. This latter prescription is in the order of things, for the main qualification for prominence in the province of rhea or ramie undertakings is susceptibility to fascination by its external characteristics—length, strength, and lustre—and the belief that it is bound to make some people's fortunes some day. That attitude of mind, if not originally inspired by the subject or object, is easily acquired by contact with the average rhea enthusiast, always assuming the absence of the positive technical criticism. The rhea enthusiasts, as a class, may be divided into two orders: the dilettante, who is as much deceived as to the exact industrial problem presented by the ramie plant, as are his financial sponsors (it is an item in the diagnosis that rhea enthusiasts are in the main impecunious); secondly, the adventurer, pure and simple, who selects with design the rhea problem as the surest road to grow a catch-crop of dupes. We all know the sequence of events in the average rhea venture promoted by the one or the other. The marvellous transformation of the rhea riband—as unpromising to look at as the peeling off an osier stick—into lustrous silky cellulose, by the application of caustic soda in indefinite quantity, followed by bleaching powder (the secret process), the capitulation of financial support, the syndicate stage with elegant offices and a superadequate staff, and then by various routes to the unromantic incidents of liquidation. We leave this side of the subject to the cynical historian, not without some regret that we have not the time, nor perhaps the qualifications, to write a profoundly instructive chapter in human philosophy.

The present position of the rhea industry—which is our proper theme—is of more healthy augury. The claims of secret process-mongers are fully discounted; there is a steadily growing industry, on an open and sound basis, in rhea yarns and cloths; the spinning problem is satisfactorily solved in more than one direction, and the all important question of supply is now recognised as merely one of proper organisation.

We must also note that with the steady growth of the industry we hear less of "fortunes" made or to be made: and this fact is partly accounted for by the steady fall in price of the staple fibres, cotton and flax, with which of course rhea comes into competition.

We may, we think, usefully put together, for the instruction of the lay public, a few of the elements of the technical problem of rhea utilisation. Keeping in view the main items of the "specification" of a commercial fibre as described in our preceding lecture we deal with the points in order:

Supply.—This question having been dealt with by Dr. Morris we may follow him in the general conclusion that the supply of raw material is assured. We hear of the cultivation of the plant in various districts of South and North America: in addition to a more systematic attention to the production of the fibre in India and China. We hear of contracts for steady supply in quantity of "ribands," negotiated at £10 to £13 a ton, and the Chinese fibre ("China grass") finds a steady sale at £30 to £32 a ton. Moreover, there appear to be two or three decorticating machines practically approved as turning out a "merchantable fibre" (ribands). The question of supply, therefore, is in a fair way towards satisfactory solution. The *chemical properties* of the fibre (cellulose) are unexceptionable. The proportion of cellulose (bleached filasse) obtained from the raw material is from 72 to 75 per cent. in the case of China grass; 60 to 70 per cent. in the case of the machine product or ordinary ribands. The cellulose when obtained is of the cotton class, considered chemically, and equally resistant to oxidising and hydrolytic agents.

The *structural characteristics* of the fibre are those changes which determine the practical problems of spinning it into yarn; in fact, to those who are interested in tracing industrial developments to ultimate causes, only to be diagnosed in this case in the province of the microscope, we strongly commend the consideration of the various solutions of the spinning problem in the case of rhea. As a matter of fact, rhea may be prepared and spun by several of the standard systems. Owing to its exceptional length of fibre it can be prepared similarly to wool and silk, and it adapts itself to portions of the systems obtaining for flax and cotton. In order to give a consecutive account of the points which arise in dealing with the fibre it will be expedient to describe briefly a complete system, the system worked out by Taylor Burrows, and in steady operation at Wraysbury. This selection is in no sense invidious, and it finds mention here chiefly because I have had the opportunity of studying it in detail.

1. The *Raw Material* employed at Wraysbury is China grass. This is taken from the press-packed bales, and the "stricks" opened and roughly scutched to the length of a few inches top and bottom, loosely tied in the middle with a band of string, and laid in the boiler, where it gets its first chemical treatment.

2. *Degumming.*—This consists in a boil at 60 lbs. steam pressure with caustic soda, after which the fibre is washed, squeezed, and hung up to dry in a warm room.

3. *1st Prepare.*—The fibre is softened by passing through heavy fluted rollers, and then begins the series of treatments by which the fibres are separated and parallelised. In the flax mill the fibre is scutched and hackled, *i.e.*, dressed with revolving "combs," a wasteful operation, which tears away a large proportion of the fibre in the tangled form of tow, only those portions resisting the somewhat barbarous treatment of the hackles, but with the fibres separated and parallelised, passing on as "dressed line." The hackling would be still more wasteful in the case of the chemically treated rhea, and a system takes its place which consists in drawing the fibre through a series of pairs of fluted rollers with differential speeds, which draw the fibres forward under considerable strain. The fibre is collected as a "lap," and passes to the

2nd prepare, in which the aid of the "gill box" enters to further subdivide and parallelise the fibres. The gills may be described as combs inserted into the strand of fibre as it travels, being drawn forward through the series of gills by a pair of fluted rollers. From the first of these machines the fibre is collected as a "lap," *i.e.*, the process is discontinuous at the delivering end of the machine. In a second similar machine, with finer gills, the turn off is a continuous flat band, or sliver. In a third machine these slivers are averaged. The loss of weight in these preparing processes is from 1 to 2 per cent. only. From the prepare the sliver passes to the most impotant process of

Combing.—The combs have the circular, horizontal, travel usual with machines of this class, the long fibres being drawn through the teeth of the slowly revolving comb, and carried forward through a pair of revolving leather blankets, and delivered as a continuous sliver. The short fibres are dealt with by the usual doffing comb, and removed as noils. As usually "operated" this machine gives a turn off of 125 to 150 lbs. per day of the long fibre sliver, the proportion of which is 66 per cent., the noils amounting to 33 per cent.

Twisting and Spinning.—The yarns are spun on the flax system; for some classes of yarns the dry method is practised, in some the roving is passed through a water trough on the spinning frame, and the fibre is, therefore, drawn and twisted in the wet state.

Reaches are all long, nothing less than 10 inches.

The system thus elaborated by Mr. Burrows is a thoroughly practical adaptation of standard principles to a particular problem. To complete the outline of the system we give the following particulars of the installation and of the output, from which practical men will draw their conclusions as to costs of production.

THE RAMIE SYNDICATE, HYTHE END MILL, STAINES, MIDDLESEX.

Estimated Manipulation and Cost for treating China Grass from the Raw Material to Yarn.

One ton of China grass at £30 per ton will produce 72½ per cent. of bleached filasse, equal to 1,624 lbs.

weight. This bleached filasse we now pass over our patent system of preparation, which reduces the fibres to the length of long wool, losing 1 per cent. of its weight, leaving 1,608 lbs. to be passed to the combing machines. The combers now take out $66\frac{2}{3}$ per cent. of long-combed sliver, leaving $33\frac{1}{3}$ per cent. of noil and waste. We now have 1,072 lbs. of combed sliver suitable for spinning into all counts of yarn, from Nos. 1 to 60, and 536 lbs. of noil, which is readily saleable at 5d. per lb. upwards. The combed sliver can be put into yarns, which will give a profit of from 6d. to 2s. per lb. Yarns from this fibre can be used for the coarser fabrics and up to the finest lace, covering a range of from twines, sail-cloth, fishing lines and nets, hose piping, &c.—where its qualities of strength and resistance to moisture are desirable—and also for stuff and dress goods, tapestry, upholstery, plushes and velvets, lace, damask cloths, sewing thread, and ladies' wraps and shawls, &c. The noils are good for mixing with wool and spinning on the wool system for all kinds of cloths. The combed sliver has been advantageously mixed with wool, as by its admirable spinning qualities it helps up weak wools, and imparts to them a certain lustre.

Estimated Cost of Plant for treating 1 Ton of China Grass daily.

	£	s.	d.
4 Degumming boilers with accessories £150	600	0	0
2 Finishing boilers with accessories £150	300	0	0
6 Combined wringers and washers £100	600	0	0
Bleach-room gearing and overhead travellers	50	0	0
8 Vats and trays £15	120	0	0
Steam and water-piping and utensils	100	0	0
1 10-roller softener £120	120	0	0
6 Patent reducing gill boxes £100	600	0	0
4 Finishing reducers £100	400	0	0
4 Finishing gills for combers £60	240	0	0
12 Combers £150	1,800	0	0
4 Doubling gills £50	200	0	0
14 Drawing frames (7 each 1st and 2nd) £135	1,890	0	0
5 Roving £300	1,500	0	0
20 Spinning £150	3,000	0	0
6 Doubling £150	900	0	0
10 Reelers £20	200	0	0
2 Bundling presses £20	40	0	0
Cans, bobbins, belting, &c.	400	0	0
	£13,060	0	0

This set of machinery produces 1,000 lbs. weight of yarn per day.

Estimate of Cost in treating China Grass—as imported—up to Yarn.

	£	s.	d.
1 ton China grass	30	0	0
Chemicals for degumming	1	9	0
Labour, unbundling, carriers up, and chargers	1	12	0
Fuel for degumming	0	15	0
Labour—washing machines	0	9	0
,, second wash	0	9	0
,, finishing boil	0	10	0
Chemicals for finishing boil	0	15	0
One foreman over girls 5s., one boy 2s.	0	7	0
One foreman boiling house	0	5	0
Labour—bleach room	0	18	0
Chemicals for bleaching	1	5	0
Labour—washing and finishing	0	9	0
,, dry house	0	12	6
Fuel for dry house	0	15	0
Labour—softening machines	0	14	0
,, reducing gill boxes	1	4	0
,, finishing reducers	0	16	0
,, finishing gills for combers	0	16	0
,, combing machines	1	10	0
,, doubling gills	0	8	0
,, 1st and 2nd drawing	1	8	0
,, roving frames	0	15	0
,, spinning frames	3	0	0
,, doubling frames	1	10	0
,, reelers	1	5	0
,, bundling presses and packing	0	8	0
Motive power	2	0	0
Wear and tear	2	0	0
Fire insurance	1	0	0
Rent, rates, and taxes	1	15	0
Office expenses	3	5	0
	£64	4	6
Less value of 536 lbs. bleached noil at 5d. per lb.	11	3	4
Cost of producing 1,072 lbs. of yarn	£53	1	2
	= $11\frac{7}{8}$d. per lb.		

We exhibit a series of samples from each stage of preparation, giving a complete demonstration of the process of refining the fibre. At the same time also we are favoured by a similar exhibit from the Rhea Fibre Treatment Company, Limited, which includes, in addition, various woven materials. The system of preparation adopted by this company is that which is applied to silk, and known as "flat dressing." The raw material is, moreover, the cruder product of machine stripping, known as rhea ribands, and the results afford in this sense a more complete, practical solution of the industrial problem.

We also include in our exhibit mixed yarns spun, *i.e.*, with mixtures of rhea with Tussah silk and with wool, which show that if the spinning capabilities of rhea are limited in the direction of the production of fine yarns, they are extensive in respect of adaptation to various classes of manufacture.

The question of the actual industrial future of rhea will, of course, be solved on the general basis of maximum advantage. Thus it may be assumed that rhea can be spun to degrees of fineness far beyond the present range, which we may take as between 20's and 50's; but the question at once arises at what cost?

Spinning qualities depend upon the ultimate physical properties of the fibre substance itself first, and next, upon the extent to which it can be brought to uniform condition in the sliver. The latter can be controlled, since by mechanical means the fibre could be sorted down to any degree of uniformity of length. But the costs of such preparation rapidly mount up and become prohibitive; and with the extraordinary variations in dimensions of the rhea fibre from 40 to 200 mm., the sub-division into fibres of uniform dimensions would involve a highly complex system. This is a problem in practical adaptations which is being effectually solved. More remote questions (1) as to whether artificial selection of the plant could accomplish a radical modification of the bast fibres to meet the exigencies of their industrial application; or (2) whether the chemist can so modify the fibre substance as to change or add to the spinning qualities, may be propounded and left to the ingenuity of technical pioneers.

The present optimum is in the region of the lower counts of yarns, and here the characteristics of the yarns are in excelsis, and entirely in accordance with the physical, structural, and chemical constants of the fibre and fibre substance.

Flax Spinning.—An item of progress is to be noted in connection with this "old-world" fibre—the application of chemical principles to the improvement of the spinning qualities of the fibre. Flax differs in essential respects from rhea; apart from structural differences it is spun not as a purified *cellulose*, but, chemically speaking, in its raw or natural condition.

In this state it contains, associated with the cellulose, 20 to 30 per cent. of a "pectic substance," a substance which is easily hydrated to gummy modifications by water and dilute alkali—being freely soluble in the latter—and also 3 to 5 per cent. of a complex of waxes and oily bodies drawn from the cuticular covering of the flax stem, with which the bast tissue is, in this plant, in very close contact.

It must be borne in mind that the condition of these substances in the commercial fibre will be different to that which obtains in the plant, in consequence of the treatment by which the plant is prepared, after pulling, for the better separation of the fibre (scutching). This treatment consists usually in a simple steeping in stagnant water. But in this long steep a fermentation is set up by which portions of the plant tissues are destructively attacked, and all are, of course, modified. The pectic constituents of the commercial fibre will therefore have undergone modification, and, with regard to the oil-wax complex, there is no doubt a further contribution of these constituents formed as products of decomposition of the cuticular tissues, chlorophyll, &c.

We mention this point because it is perhaps overlooked by inventors who propose from time to time "artificial" methods of retting flax: they consider too much the one question of the separation of the fibre from the stem (wood and cortex) and too little the important question of the spinning qualities of the fibre and the extent of their dependence upon the non-cellulose constituents of the fibre.

From this brief *resumé* of the specific chemical features of the flax fibre it will be appreciated that the fibres are influenced by maceration in water, and that the waxes and oils would be rendered more fluid by steeping in warm water. Hence the stages of industrial progress in spinning flax yarns: (*a*) From dry spinning to spinning the roving previously macerated in cold water; (*b*) from cold to hot water spinning, the hot water being contained in troughs upon the spinning frame. So that the roving is treated immediately before receiving its final drawing and twisting. The consequent improvement in spinning qualities shows itself in the production of yarns of increasing fineness. But for this the machinery employed requires to be adapted *pari passu*.

Excluding details, the one main mechanical factor of the fineness and uniformity of a yarn is the reduction of the distance between the two pairs of rollers constituting the "draught" or drawing system. It is this drawing action which immediately precedes the twist or spinning process proper; and a little consideration will show that the length of draught is conditioned by the length of the actual spinning unit of the fibre under treatment. In the dry spinning of flax the unit is a filament, or bundle of fibres, of some inches in length; in wet spinning, owing to the softness of the fibre substance, and its lubrication by the oil-wax constituents, raised to a fluid state, the draught on the frame tends to further subdivide the fibre smaller. The spinning unit is, therefore, much reduced in length, and the spinning "draughts" are proportionately reduced, say to 2¾ to 3½ inches.

By chemical treatment it might be presumed that this process of refinement could be carried still further, and my researches on the flax fibre in 1887 led to the application of the results by C. C. Connor, of Belfast, to an improvement of flax spinning in this direction.

As already explained, the roving as finally prepared, passes through a trough of hot water upon the spinning frame. The process in question consists in intensifying this maceration by the addition to the water of certain soluble salts, such as sodium phosphate. The action of such a salt is directed both to the oil-wax components of the raw flax, as well as to its pectic or gummy constituent, the result being that the sub-division and drawing of the fibres is facilitated. This is taken advantage of by reducing the "reach," the distances between the retaining and drawing rollers on this system varying from 1·6 in. to 2·2 in., according to the fineness of the yarns. The yarn gains proportionately in "cleanness" and in elasticity, both being important weaving qualities.

This system is exclusively worked at the mill of the Irish Flax Spinning Co., Belfast, the technical and financial success of this concern over a lengthened period being sufficient evidence of the soundness of the method.

By these few examples of progress in cellulose technology it is intended to illustrate some important general principles, rather than to attempt an exhaustive or detailed survey of what has been done, or the more difficult task of forecasting what will be done in the next few years.

I may, perhaps, be allowed to suggest that the amount of investigation devoted to these subjects is ridiculously inadequate. Probably there is an impression abroad that this field of work is being exhausted. The few who work in it best know that the exhaustion is that of means and methods, not of the subject-matter.

Correspondence.

MINING AT GREAT DEPTHS.

MR. BENNETT H. BROUGH writes:—In the paper I had the honour of reading before the Society on the 9th of December last, in order to give an idea of the depth to which mine workings have penetrated, I enumerated some of the more important deep shafts. I regret to learn from Oberbergrath Menzel, of Freiberg, that in this list there is an error, copied from Serlo's *Bergbaukunde* (4th edition, 1884), in the case of one of the German shafts cited. The Einigkeit shaft at Zwickau in Saxony is erroneously described as the Einigkeit shaft at Lugau in Saxony, a shaft that was abandoned in 1860. In pointing out this error Oberbergrath Menzel adds the very valuable information that at the present time the deepest shaft in Saxony is the No. II. shaft of the Bockwahohndorf Colliery Company in the Lugau-Oelsnitz district. This is now 2,932 feet deep. The greatest depth in the Saxon ore mines has been attained at the Glückauf shaft of the Himmelsfürst mine at Brand, which is 2,251 feet deep. The greatest depth ever attained in Saxony was 3,046 feet, was reached in 1876 by the now abandoned Frisch-Glück shaft in the Lugau-Oelsnitz coalfield.

General Notes.

TWENTY-FOUR HOUR DAY.—By decision of the Belgian Minister of Railways, Posts, and Telegraphs, the hours in that country have, since the 1st of May, been reckoned from 0 to 24, noon being represented by 12, and midnight by 0 or 24, according to circumstances. In the case of a train starting exactly at midnight, it is said to leave at 0 hour; and one arriving exactly at midnight is considered due at 24 hours, or, as we should say, at 24 o'clock. On the time-tables, the times between midnight and 1 a.m. are indicated by a zero, followed by a point and the letter H, the latter followed in turn by the number of minutes. The dials of existing clocks at railway-stations are completed by the figures 13, 14, 15, &c., to 24, added below the existing figures of 1, 2, 3, &c., to 12. This change, which should have come into force with the new year, was deferred for three months, on account of the administrative difficulties which it involved, and also in the hope that the Greenwich meridian, now adopted in Belgium, might also be accepted by France at the same time, urgency having been voted for a measure to that effect by the Chamber of Deputies. In consequence of this change, the official time-tables of the Belgian railways, formerly published in square form, like "Bradshaw," now form a very presentable small 8vo. volume with highly artistic cover, giving views of various picturesque sites, on a ground *semé* (as the heralds have it) with front elevations of locomotives.

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FRIDAY, JULY 2, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ADDRESS TO THE QUEEN.

The following is the text of the Address to the Queen, presented by H.R.H. the President on behalf of the Society, on the occasion of Her Majesty's Jubilee (see p. 733).

To Her Most Gracious Majesty the Queen.

May it please Your Majesty,—We, your Majesty's most dutiful and loyal subjects, the Members of the Society for the Encouragement of Arts, Manufactures, and Commerce, humbly tender to your Majesty our respectful congratulations on the approaching completion of the sixtieth year of your Majesty's beneficent and prosperous reign.

Under the Presidency of your Majesty's illustrious consort, which continued over a period of eighteen years, it was the distinguished privilege of the Society to organise the Great Exhibition of 1851, by which, for the first time, the arts and industries of the whole world were collected together; while under the Presidency of His Royal Highness the Prince of Wales, the Society has since taken an important part in the promotion of many subsequent exhibitions of a similar kind. In this and in other ways the Society has been actively concerned in the promotion of those applications of science to the industrial arts by which your Majesty's reign has been so eminently characterised, and by which the health, happiness, and prosperity of your Majesty's subjects have been so greatly increased. The Members of the Society have therefore special cause to unite with their fellow subjects throughout the Empire in thankfulness to the Almighty for the blessings which have been vouchsafed to them under your Majesty's most fortunate sovereignty, and in fervent prayer for your Majesty's continued peace, well-being, and happiness.

Albert Edward,
President.

Sealed with the Seal of the Society
for the Encouragement of Arts,
Manufactures, and Commerce this
Fourteenth day of June, 1897,
in the presence of

O. T. Burne,
Chairman of Council.

Henry Trueman Wood,
Secretary to the Society.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The continuation of the report of the proceedings of the Congress will be printed in the next number of the *Journal*, when the publication of the papers and the discussion will be commenced.

Proceedings of the Society.

CANTOR LECTURES.

THE INDUSTRIAL USES OF CELLULOSE.

By C. F. Cross.

Lecture III.—Delivered February 29, 1897.

So far we have been dealing with the celluloses and allied compounds in their natural or fibrous forms, and the chemical principles involved in their manufacture and use which are chiefly of the negative order. The celluloses, in fact, are useful by reason of their fibrous organisation first, and secondly by reason of their resistance to the destructive agencies of the natural world. Their special interest to the chemist begins with the consideration of them as reactive substances, or chemical individuals capable of conversion into derivative compounds, either by decomposition, *i.e.*, a splitting up into other bodies, or by combination or synthesis with other molecules.

The decomposition of the celluloses are, of course, of great importance in their systematic investigation, but the questions which they suggest are at the present time mainly of theoretical interest. Two of these, however, may be briefly noted as having a direct, if not very obvious, bearing upon industry. Both arise in the problem of the *proximate* resolution of cellulose. Cellulose resembles starch in having the same ultimate composition—that represented by the formula $C_6H_{10}O_5$—and in being decomposable into simpler molecules, which are *sugars*. In the case of starch this transformation is determined by a number of "ferment" actions, and by the further action of certain ferments the resulting sugars are finally broken up into such simple products as alcohol and carbonic acid. The celluloses are resolved by chemical treatments, more or less severe, and yield fermentable sugars.

Now, the industrial value of the starches, and of farinaceous seeds depends chiefly upon these properties: (1) In regard to their value as food stuffs; (2) As the raw material for our more important alcohol industries. The celluloses, therefore, have to be considered from these points of view, in comparison with starch. It will be evident that the celluloses are more valuable in these directions as they offer *less* resistance to chemical treatment. It is, in fact, when we come to the celluloses of the straw group that we meet with forms which are easily attacked by acids and alkalies and by microscopic organisms under suitable conditions. These celluloses are, therefore, more or less digestible by animals, and have therefore a certain feeding value in their natural state: and, again, are easily attacked by acid treatments to yield alcohol-forming sugars. A very interesting group of industrial problems centre round these facts. We shall not discuss them here as they involve controversial points on the one hand, and unproved industrial probabilities on the other. They will be found discussed in a recent paper to the Institute of Brewing, and readers are referred to the journal of that society for further information. [" Jour. Fed. Inst. Brewing," Jan. 1897.]

Important and more generally interesting developments are opened up by the other side of the chemical reactivity of the celluloses, and the derivative compounds formed by combination or synthesis are the basis of flourishing industries as of new industries with equally promising careers before them.

It has been for a long time an aim of Invention (with a capital I) to bring cellulose into plastic forms. Its extraordinary physical properties and the endless variety of forms in which it is handed over to us by and from the vegetable world suggest vast structural capabilities. And—to read history perhaps backwards—as it is evident that plants must work up these forms from an anterior plastic form of solution or semi-solution, so it is continually suggested to us as chemists that we ought to be able to reverse the process and get back from the fibrous structures to the structureless homogeneous condition of a solution. As we have said, this is perhaps reading events backwards, and it is not probable that those who have provided us with solvents of cellulose have started their inventive ventures from this point of view.

The *solvents of cellulose* are not numerous, and they are extremely varied in their character. It is not necessary to describe them in detail, as they also have been the subject of a special paper recently communicated to the Photographic Society (see "Jour. R.P.S.," 1896); but it will be instructive to group them together here from the common point of view of a conversion of cellulose into soluble or plastic modifications, and to contrast them in regard to costs and industrial applications.

Group A. Aqueous solvents, the solvents being metallic compounds of saline character, and solution resulting from interaction of acid and basic groups *reciprocally* of the cellulose and the solvent.

(1) *Neutral.* Zinc chloride in concentrated aqueous solution (40 per cent. $ZnCl_2$). Process: A long digestion at a temperature of 90 to 100°.

(2) *Acid.* Zinc chloride dissolved in twice its weight of strong aqueous hydrochloric acid. Process: Action of solvent instantaneous in the cold.

(3) *Alkaline.* Cupric oxide (hydrate) 3 per cent. solution in aqueous ammonia (15 per cent. NH_3). Process: Rapid solution in the cold.

Group B. Aqueous solution of alkaline sulphocarbonate of cellulose, the formation of a definite water-soluble compound by synthesis in two stages. (1) Combination of cellulose with caustic soda; (2) combination of alkali-cellulose with carbon disulphide.

Group C. The cellulose previously converted into compound esters by combination with negative groups, and solution of these in appropriate solvents.

(1) Nitrates. (2) Acetates. (3) Benzoates.

These various methods, although of very divergent character, have the one common object or result of bringing the cellulose into a structureless or homogenous and plastic form: and although the forms in which the cellulose is dissolved are consequently of very divergent character, it is evident, from a study of the solutions, that the physical properties of the soluble forms are in the main those of cellulose itself, its association in combination with other groups causing no essential changes in these properties.

To compare the costs of dissolving cellulose by these various treatments we may take as a basis a 10 per cent. solution, and consider only the materials used:—

Zinc Chloride.—Solution of 1·5 Sp.br. (100° Tw), quoted at £5 10s., 1 ton cellulose with 9 tons of solvent brings the total cost of solution to £45 to £55 per ton of cellulose.

The acid solution (2) would cost somewhat more, but as no industrial uses of this solvent are at present forthcoming it is sufficient to note the approximate cost.

Cuprammonium.—Taking ammonia (NH_3) at £55 per ton and copper at £50, 9 tons of solvent would cost :—

For ammonia at 15 per cent., £74
,, copper ,, 2 ,, £9

or £83 per ton of cellulose additional cost.

Alkaline Sulphocarbonate (or Viscose).—
For 1 ton cellulose, 10 cwt. caustic soda, £4,
,, ,, ,, ,, carbon disulphide, £7

Acid Esters.—The costs are more difficult to estimate owing to the variety of methods available for preparing the cellulose compounds and the variety of reagents employed in the preparation of the solutions. From a careful estimate of continuous production of the soluble nitrates (pyroxyline) in solution in ether-alcohol, the costs of a 10 per cent. solution are made up as follows : cotton at 3½ per lb. is converted into nitrate at a cost of 9½d., and dissolved in ether alcohol to a 10 per cent. solution at an additional cost of 3s. to 4s.

In the industrial applications of these solvents, or of the cellulose solutions, a number of subsidiary questions of economy have to be considered, chiefly the extent to which the solvents can be recovered. These questions we do not propose to discuss except in special cases. One important point, however, results from the comparison of costs, even if this may be objected to as somewhat superficial, and, therefore, only a crude approximation to the facts, that is, that the sulpho-carbonate treatment is by far the most economical of all the methods of dissolving cellulose. We shall, therefore, consider this process somewhat more in detail, for the evident reason that it brings cellulose in its soluble form within the range of a number of industrial applications hitherto excluded.

The raw material is cellulose in any form, or any of the varieties mentioned in a previous lecture. The cellulose requires to be very intimately incorporated with caustic soda and water, and the following are the essential points in the composition of the ordinary product :—

The proportions by weight are cellulose : caustic soda = 100 : 50, and the water on the same proportionate basis must not exceed 300.

To make this product is not an altogether simple operation ; the cellulose requires to be reduced by mechanical means to a fine condition of sub-division, and if this is carried out in a paper maker's beater, the pulp must be pressed so as to contain not more than 50 per cent. moisture. This is then ground in a kollergang or edge runner, the caustic soda in strong solution being added gradually. The proportion is so calculated that the finished product contains :—

Cellulose....	25	
Caustic Soda	12	The water in the pressed cellulose, together with that necessary to dissolve the caustic soda, is calculated to 5 times, or, at the outside, 6 times the weight of the latter.
Water......	63	
	100	

This is the product known as alkali cellulose. Chemists will observe that the molecular ratio of the chief components is $C_6H_{10}O_5$, 2NaOH.

A second form of the product with only one-half this proportion of alkali is obtainable from cellulose previously treated with boiling dilute mineral acids. This treatment brings about a structural disintegration as well as a certain chemical change ; the latter resulting in its being convertible into a perfectly soluble sulphocarbonate with one-half the proportion of the reagents. The alkali cellulose from this product is finished to contain :—

Cellulose....	45	
Caustic Soda	11	Less water is used in this case, the total being calculated to 4 times the weight of the caustic soda.
Water......	44	
	100	

Before passing to the consideration of the further treatment of these two particular forms of alkali cellulose, we may pause to take a view of the reaction involving applications of a very different order. The reaction itself was first studied by John Mercer, and, indeed, is known after his name as the process of "Mercerisation" of cellulose. Mercer studied the reaction exclusively as affecting cellulose textiles or cloth, and a very interesting account of his researches will be found in "The Life and Labours of John Mercer," by E. A. Parnell, London, 1886. With regard to cloth, the physical changes which take place are very evident by the skrinkage or "fulling" effect which is determined, viz., from 20 to 25 per cent. in linear dimensions. In spite of the possibilties opened up by Mercer's original observations, the process had been very little used in the textile trades until a few years ago when it was found that by the local or topical action of strong alkaline solutions upon cotton fabrics, the shrinkage determined caused strains to be set up in the part of the fabric so treated, the untreated portions showing the effects of "crinkling." By such methods the "crêpon" prints, which have proved so very attractive during the last three years, have been produced.

Out of this one simple effect also the variety of designs obtainable have been extremely numerous, and there are exhibited a range of such cloths illustrating this interesting phase of variety in the application of a single and very simple reaction. As a correlative to this, I may mention also that acids have a similar effect upon animal fibres (wool and silk), and therefore upon the fabrics produced from them. This also has been taken advantage of in a similar way, the cloths being treated by strong acids locally or topically in various ways producing crinkled or crêpon effects. We cannot study this matter in further detail as no further principles are involved than those indicated. We pass on, therefore, to consider the further application which has been made of the reaction that takes place between cellulose and caustic soda, viz., for the purpose of producing water-soluble derivatives of the cellulose.

The second stage in the process is the treatment of the alkali-cellulose with carbon sulphide in closed vessels. This is an extremely simple operation. The alkali-cellulose being a semi-dry solid, resembling bread crumbs in appearance, is easily mixed with the bisulphide by rotating the containing vessel for a few minutes after adding the latter. It is then left at rest for 1 to 3 hours, according to the temperature, the longer time being required at temperatures of 40° to 50° F., the shorter at 70° to 80° F.

At the end of the operation there is little change in the appearance of the mass, except in regard to colour, the sulpho-carbonate thus formed having a pale yellow colour.

It is now dissolved in water with the aid of powerful stirring apparatus. The solution being extremely viscous, and diffusion of water to the centre of any lumps being therefore practically cut off, it is necessary to prevent their formation as far as possible. Hence the previous operation should always be arrested while the product is still a free, or non-coherent mass; if left to itself aggregation ensues, and the transparent, dough-like masses which are formed are extremely difficult to break up.

The solution, or viscose, is made up usually to contain ten parts of dissolved cellulose per 100 of total solution by weight.

The industrial uses of viscose depends upon its property of readily decomposing with regeneration of cellulose in the solid but structureless form, the cellulose being recovered without loss, and with full preservation of its essential chemical properties. We indicate the various modes of decomposition and the industrial uses which they subserve*:—

1. *Spontaneous.*—The viscose "sets" at ordinary temperatures to a solid mass of cellulose (hydrate). The mass has at first the volume of the containing vessel, then shrinks, at the same time expressing the alkaline solution of the by-products. From these it may be entirely freed by washing, and on exposure it slowly dries or dehydrates to extremely hard masses of cellulose (viscoid).

Application.—The production of solids known as viscoid, either consisting of pure cellulose, or mixture of celluloses and other substances, added originally to the viscose, such as zinc oxide (opaque white solids), iron oxide (brown and red solids), ground wood or cork dust (solids specifically lighter than water), or the cellulose may be coloured by the admixture of dye stuffs.

2. *By heat.*—The viscose is rapidly decomposed at 70 to 100° C., and this affords a simple method of "fixing" the cellulose, and at the same time dehydrating and shrinking it.

Application.—(*a*) Production of films or sheets of pure cellulose by evaporation upon smooth resistant surfaces, such as glass or iron. The films are detached by immersion in water, and are easily washed free from the alkaline by-products; (*b*) Production of films upon fabrics, the viscose being so applied, *e.g.*, by knife-spreading machines, as to form an unbroken film. The fabric is then exposed to heat, and afterwards washed to remove the by-products; (*c*) Filled finishes upon cotton and linen goods. In this case the viscose is squeezed into the cloth by treatment in a mangle; the cellulose is fixed by hot drying; the by-products are then washed away, and the cloth may then be boiled, bleached, or dyed without in any way affecting the cellulose so fixed.

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* Referring chemical readers for more detailed accounts of the product to "Trans. Chem. Soc."; "Bull. Soc. Chem.," 1893.

3. *By reaction with other compounds.*—Acids and other compounds, which combine with soda, cause a very rapid decomposition. Metallic salts, which react by double decomposition, also abstract the soda from the compound, and form metallic compounds of the cellulose—sulpho-carbonic acid. These are nearly all insoluble compounds, and quickly decompose, cellulose being set free, carbon disulphide also in greater or less proportion (a maximum with zinc salts), the residue of the sulphur going to form the corresponding metallic sulphide. These reactions are made use of in the process of sizing paper pulp (in the engine); zinc sulphate is used preferably as the "fixing" salt for the reasons—(1) it causes the expulsion of a large proportion of sulphur as carbon disulphide; (2) the residue of sulphur forms zinc sulphide, which is *colourless*, and which is not decomposed by sulphate of alumina, used in the auxiliary process of rosin sizing. Magnesium sulphate is also used, with the advantage of cheapness. This salt also enables us to eliminate the greater proportion of the sulphur, but the result is rather due to the ordinary action of the air, which is beaten into the mass of pulp by the severe action of the beater rolls.

To illustrate these multifarious applications thus sketched in detail, we exhibit a series of specimens as follows:—

Special Products.—(*a*) "Viscoid" solids: Pure cellulose in blocks, and articles turned from them; also mixtures of cellulose with zinc oxide, cork dust, sawdust, and coloured with pigments and dyes; (*b*) sheets cut and finished from blocks of coagulated cellulose (hydrate), and prepared by drying down upon glass surfaces; (*c*) the regenerated cellulose in fine powder and meal, as used for conversion into nitrates and acetates (infra).

2. Textile fabrics treated in various ways with viscose—*i.e.* (after removal of the by-products), with cellulose.

(*a*) Coated with films of cellulose, pure and coloured.

(*b*) "Filled" with cellulose as a permanent finish, a finish that is which resists boiling, bleaching, laundrying, &c., in the same way as the cellulose film of the original fabric.

(*c*) 2 to 6 ply cloth, fixed together by means of the cellulose, and similarly resistant to the action of water and chemical agents.

(*d*) Printed calicoes, the colours being applied to the cloth by means of viscose employed as the viscous medium or vehicle.

3. Papers treated with viscous in various ways.

(*a*) Coated or filmed on one side only.

(*b*) Coated on both sides or indurated with the cellulose by passing through a bath of the viscose and removing the excess by squeezing rollers.

(*c*) Engine sized or treated in the pulp.

The technical advantages arising out of the properties of this new derivative of cellulose are effectually summed up in its one main aspect—viz., that it supplies at low cost cellulose in a homogeneous, plastic, or liquid form, in which form it is easily handled, and from which it is readily recovered without loss or essential chemical change. With regard to its particular applications, these depend upon the unique properties of the substance, its exceptional characteristics being quite as remarkable in its soluble forms as in the countless solid modifications in which it occurs in the natural world, to which we may now add the "artificial" varieties here exhibited.

We now have to deal with two more special industrial applications of the cellulose *regenerated* from its solution as viscose.

The first of these is its employment as the basis of a "smokeless powder," *i.e.*, as a propulsive explosive for use in firearms. It is a matter of public knowledge that the "black gunpowder" which has played so large a part in the up-building of the modern polity of nations, is rapidly giving way before these smokeless powders of which gun cotton is the basis.

The purely technical aspects of the inventions by which this development has been achieved have been so much before the public within the last two years that we have only to mention the leading products of this class by name, *e.g.*, ballistite, cordite, maximite, to bring our audience in full view of the main principles involved in their production. These nitro-glycerin nitro-cellulose powders have the striking feature of *regulated combustion*, and therefore adapted to propulsive explosion, whereas the two components considered separately are blasting explosives, producing enormous pressures on combustion in a closed chamber, and therefore outside any possible use with projectiles. These effects are due to physical as well as chemical causes; the nitro-celluloses are fibrous, exactly resembling the original cellulose or cotton; they expose an enormous surface, and combustion is propagated throughout a mass of gun cotton with enormous rapidity. Nitro-glycerin is a liquid, and on the chemical view of explosives, of unique constitution, containing an excess of oxygen beyond that necessary for complete (gaseous) combustion. This compound is a "high explosive," and its super-sensitive habit and destructive actions are too well known to need description. The mixture of the two results in a gelatinisation of the cellulose, and the formation of a homogeneous product which can be drawn or rolled into threads or sheets. This product, in addition to its superior properties as an explosive, greatly facilitates the details of sub-division into "charges," and making up into the forms required for military purposes. But with all these advantages there are many strong objections to the nitroglycerin powders. It is sufficient evidence of the weighty character of these objections to note that the sheets have been largely adopted by the French and German Governments while the powders have not; and the wisdom of our own War Office in its strong preference for cordite, to the extent also of the spending of much public money in the defence of the patents by which the manufacture of cordite is "protected," is very much questioned by qualified experts.

We make no pretence to enter upon a discussion of these much controverted questions. We have the more practical task of recording some new developments which are being worked out at the Dartford factory of Messrs. Pigou, Wilks, and Laurence. The basis of these developments is the nitro-cellulose prepared by "nitrating" the structureless cellulose obtained from the sulphocarbonate solution or viscose. The originators of this departure are Messrs. Luck and Durnford, of the above firm, their invention being described in the specification of the patent by which it is "protected," No. 4,769, 1895. What we may call the theoretical basis of the invention is the assumption that the *essential feature* of a propulsive explosive, of which nitro-cellulose is the chief component, is that it should be *structureless* or *non-fibrous*. That being the case, it is in this respect immaterial whether this character is imparted before or after nitration. But there are obvious advantages to be secured if it can be shown that the nitrate obtained from the cellulose fulfils *per se* all the complicated requirements of a military powder. First, the elimination of nitro-glycerin, which is always an added element of danger, and getting rid of the dangers of working up the two high explosives into sheets or threads; second, on the important grounds of simplification and economy of manufacture; thirdly, it would restore the smokeless gunpowder question to the routine of the old black-powder processes.

These points we are in a position to illustrate by a series of manufactured products, kindly contributed by the inventors, Messrs. Luck and Durnford.

1. The cellulose itself is easily obtained as a fine meal, or a gritty powder. We say "easily," implying thereby the added qualification "when you know how." As a matter of fact, it has taken the inventors some considerable study to obtain the cellulose from the sulpho-carbonate solution in an entirely satisfactory condition. The treatment, we have reason to know, is now so simplified as to justify the remark that the *matière première* is obtainable with ease.

That the cost is low is a matter of simple calculation from the particulars previously given.

(2) The *nitrate*, or "nitro-cellulose" is a product exactly similar in appearance. It is a dense powder. The nitration is carried out by stirring the fine powder into the acid mixture (nitric and sulphuric acids), and after leaving some time it is drained off, and then exhaustively washed. The washing is a very simple operation by reason of the rapid subsidence of the product. The specimens shown, contain from 13·1 to 13·4 per cent. nitrogen.

3, The "powders" are made up from the nitrates thus prepared into granulated forms of various degrees of coarseness, or may be compressed into cylinders, the cylinders shown having the dimensions 2″ × $\frac{3}{4}$″.

Experts will recognise in these specimens the attempt to solve the various problems of explosive effects, obtainable with this raw material, on the lines of previous experience with the black powders, *i.e.*, by suitably varying the form and dimensions of the masses into which it is finally worked up, and again by such auxiliaries as glazing, or, in certain cases, by admixture with other ingredients.

These powders are found to answer most satisfactorily to the strongest Government tests for permanence and stability.

It is a matter of common knowledge that the nitrates of cellulose lend themselves to a group of applications of very opposite characters, viz., as structural materials. The earlier of such applications take the well-known forms of xylonite, celluloid, &c., products with which we are familiar in the form of sheets, or films, and masses capable of moulding or fashioning at the craftsman's will. Through the kindness of the British Xylonite Company I am able to exhibit a representative range of specimens upon the utility and elegance of which it is unnecessary to enlarge. In regard to the technical principles underlying this manufacture, I may point out the more important :—(1) The cellulose nitrates used in the manufacture retain the fibrous form of the original cellulose; but they are soluble in a number of liquids under the action of which, therefore, they are reduced to structureless homogeneous viscous liquids, or plastic masses. It is these properties of solubility which condition the processes of working up the fibrous nitrates into the forms before us. (2) The structural properties of the products are rather those of the cellulose itself, the conversion into nitrate having the main object of bringing it into the soluble plastic and structureless forms. This is sufficiently established by a comparison of the various forms of celluloid with the corresponding forms of the cellulose itself as obtained from its solutions as thiocarbonate or viscose.

Now, there are other soluble compounds of cellulose similarly formed by combination with negative or acid groups. As the nitrates are formed by the direct combination of cellulose with nitric acid (with elimination of water), so the acetates of cellulose result from a similar combination with acetic acid. The production of these esters of cellulose from the fibrous celluloses is, however, a difficult and tedious operation, impracticable on the manufacturing scale.

Starting, however, from the structureless cellulose, above described as the raw material for the new form of nitrates, we have devised a simple method by which these acetates may be economically prepared on the large scale. (Cross and Bevan, English patent, No. 9676, 1894).

After suitable purification the acetates are obtained in a form freely soluble in a number of liquids, and capable, therefore, of a variety of applications. Specimens of these products in various forms are exhibited; perhaps the most striking is the brilliant transparent film of 1/100 m.m. thickness. The product being in no sense explosive, and not melting until a temperature of over 200° C. is reached, it has, in these respects, very obvious advantages over the nitrates which, otherwise, it closely resembles in physical properties.

As the manufacture and use of these compounds are only as yet in their infancy, it would be unwise to prophecy concerning them, and the extent to which they will receive industrial application. We must content ourselves with this brief and general notice.

Lastly, we have to notice the exhibit with which we have been favoured by the Lehner Artificial Silk Co. of their brilliant product the artificial silk or "lustra-cellulose." * We are entitled to describe this as an achievment in applied science of a very high order. Having recently published a technical account of the invention ("Jour. Soc. Chem. Ind." 1896), it will be sufficient to notice here, in brief, its main features. The solution of the nitrates above described have a high viscosity, and when allowed to flow into certain liquids which mix with the solvents but are not themselves solvents of the nitrates, the latter are precipitated, and under suitable conditions the precipitation takes the form of a solid continuous thread of uniform diameter. This is the basis of the spinning process. The solvent used for the nitrate is ether alcohol, and the precipitating liquid is water. The flow of the viscous collodion is regulated by gravitation until it reaches the spinning orifice, which is of extreme fineness, and submerged in a cell or trough of water. The thread formed in the water is drawn forward under a constant tension. Several of these threads are drawn through a single orifice, and suitably twisted into a composite thread which is then wound into the usual hank form. The resulting thread or yarn then undergoes a simple chemical treatment, whereby the combined nitric acid is removed and the substance of the thread reconverted into a pure cellulose. The cellulose being now, however, a homogeneous rod or cylinder (with a minute central canal or hollow), is endowed with high lustre, and fulfils all the requirements of a textile yarn. It is satisfactory to be able to add information that the work of the inventor, Dr. Lehner, of Zurich, has been crowned with industrial success, and the entire output of the work at Glattbrugg, near Zurich, which is steadily maintained at a maximum, is sold without effort at the very high range of prices of 25 to

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* The selection of the "Lehner" process and product for mention and exhibition is in no sense invidious. It is due to de Chardonnet to recognise his earlier and pioneer work (1883-90).

30 francs per kilo, a figure which allows a liberal margin of profit.

This beautiful and interesting product and technical achievement forms a fitting close of these lectures. My aim has been not to attempt a systematic or exhaustive treatment of the subject, but to deal with representative selections of the many problems which it presents to the technologist; also to convey by suitable object-lessons and to the rising generation of chemists some idea of the fruitfulness of this field of work and investigation with the hope that they will be attracted to it as to a veritable land of promise.

I am indebted to a number of friends for valuable assistance in connection with these lectures. To the various firms who have contributed exhibits, and whose names I have mentioned, I wish to return my thanks. To Professor Hummel, of the Yorkshire College, also, for the loan of a very interesting exhibit of printed fabrics. I am particularly also indebted to my friend, Mr. Clayton Beadle, for the trouble he has taken in preparing and showing the experimental demonstrations.

The following is a list of the special exhibits illustrating these lectures, with the names of the contributors:—

Papers.

Rag cellulose papers, Messrs. W. Joynson and Son, St. Mary Cray.

Wood cellulose papers, the Ekman Pulp and Paper Co., Northfleet.

Esparto cellulose papers, Royal Paper Mills (McMurray), Wandsworth.

German normal papers, Aktiengesellschaft f. Papierf, Penig, Saxony.

Test papers for quantitative estimation of mechanical wood pulp and of active oxygen in papers, Dr. Casimir Wurster.

Drawings and specifications of "Mather" bleaching kier and installation, Messrs. Mather and Platt, Manchester.

Specimens illustrating linen and damask bleaching, Messrs. Lumsden and Mackenzie, Perth.

China grass and Ramie products, the Ramie Syndicate, Wraysbury, and

The Rhea Treatment Co. (Gomess process), 17, Shaftesbury-avenue, W.

Flax yarns (Connor's patent), the Irish Flax Spinning Co., Belfast.

Specimens illustrating printed crêpon effects in cotton, wool, and silk cloths, Professor J. J. Hummel, Yorkshire College, Leeds.

Viscose and Viscoid Products.

The Viscose Syndicate, 3, New-court, London, W.C.

The British Viscoid Company, Erith.

Xylonite (Celluloid), the British Xylonite Company, Manningtree.

Lustra-Cellulose, the Lehner Artificial Silk Company, Dunedin-house, E.C.

L. D. Smokeless Gunpowders, Messrs. Pigou, Wilks, and Laurence, Dartford.

Cellulose Acetates.

I. Frankenburg, Salford.

The following works and monographs have been consulted in the preparation of these lectures:—

"Pflanzenfaser." Hugo Müller.

"Etudes sur les Fibres Végetales Textiles." Vétillart, Paris, 1876. (A useful abstract of this work is published by Thomas Christy, F.L.S., in "New Commercial Plants.")

"Chemische Technologie der Gespinnstfasern." Braunschweig, 1888. O. N. Witt.

"Cellulose." Cross and Bevan, London, 1895.

"Commercial Fibres." O. Morris (Cantor Lectures, 1895).

Le Collage des Papiers. C. Wurster, Bull. Soc. Mulhouse, 1878, 726-801.

Mittheilungen d. K. K. Versuchsanstalt. Berlin, 1885-97.

ANNUAL GENERAL MEETING.

The Annual General Meeting, for receiving the report of the Council, and the Treasurers' Statement of Receipts, Payments, and Expenditure during the past year, aud also for the Election of Officers, was held, in accordance with the Bye-laws, on Wednesday last, the 30th June, at four p.m., Major-General Sir OWEN TUDOR BURNE, G.C.I.E., K.C.S.I., Chairman of the Council, in the chair.

The SECRETARY read the notice convening the meeting, and the minutes of the last annual meeting.

The following candidates were proposed, ballotted for, and duly elected members of the Society:—

Barraclough, Thomas, 69, Ashley-gardens, Victoria-street, S.W.

Bell, Andrew Walker, Burgh-chambers, Dunfermline.

Brown, William Peter, 3, Austin-friars, E.C.

Cross, Charles Frederick, 4, New-court, Lincoln's-inn, W.C.

Davson, Henry K., 31, Porchester-square, W.

Ewens, George Thomas, West-hall, Kew.

Flood, Alfred Edward, Rowborough, Cookham, Berks.

Fraser, Frank H., 98, Commercial-road East, E.
Hey, Harry, 2, Ash-terrace, Savile-town, Dewsbury.
Jacob, Thomas, 10, Vicar's-road, Haverstock-hill, N.W.
Janson, Frederick Halsey, 60, Westbourne-terrace, W.
Lugard, Brig.-General Edward J., The Highlands, Coonoor, South India.
Mitchell, James F. B., Clerk-road, Jacob-circle, Bombay, India.
Mylne, Rev. Robert Scott, B.C.L., Great Amwell, Herts.
Reed, Ernest C., Riverside Mills, Dartford, Kent.
Reed, Thomas, 63, King-street, South Shields.
Root, John, jun., Colombo, Ceylon.
Rylands, Mrs. Enriqueta, Longford-hall, Stretford, Manchester.
Scherzer, Albert John, Santa Ana, Republic of Salvador, Central America.
Settna, Maneckjee Framjee Hormusjee, Marknes-buildings, Fort, Bombay, India.
Verney, Frederick, 6, Onslow-gardens, S.W.
Wadham, Arthur, 171, Queen Victoria-street, E.C.
Watkins, Jonah, The Bank, Llandovery.
Williams, John Taylor, 2, Queen-street, Wellington, Salop.

AND AS HONORARY FOREIGN CORRESPONDING MEMBERS :—

Cornu, Professor Marie Alfred, For.Memb.R.S., Memb. Acad. des Sciences, Bureau des Longitudes, Professor a l'Ecole Polytechnique, Paris.
Linde, Professor Carl, Nymphenburgerstrasse, 76, Munich.
Marey, Professor E. J., Paris.
Meyer, Professor Victor, Ph.D., University of Heidelberg.
Newcomb, Professor Simon, LL.D., For.Memb. R.S., United States Naval Observatory, Washington, D.C.
Rowland, Henry A., For.Memb.R.S., Baltimore.

The Chairman nominated Mr. John Jewell Vezey and Mr. Thomas Bolas, scrutineers, and declared the ballot open.

The SECRETARY then read the following

REPORT OF COUNCIL.

With the end of the Session the Society has completed a period of fifty years under its Royal Charter, since it was incorporated in 1847, after ninety-three years of previous existence. The progress which has been made is very remarkable, and the members are certainly to be congratulated on the position the Society now occupies as compared with that which it held at the date of its incorporation. The period has been too long, and the work too multifarious, to justify any attempt at summarising it within the limits which can be permitted to an annual report; but it is worth while drawing attention to the fact that this year forms the Jubilee of the Society in its present and modern form.

I.—ORDINARY MEETINGS.

The Session was opened on the 18th of November last by an address, which, in accordance with the bye-laws, was delivered by Major-General Sir Owen Tudor Burne, the Chairman of the Council. Sir Owen Burne selected for his subject the "Arts, Manufactures and Commerce of India," a subject with which his long experience in India, and afterwards as a Member of the Council of India, specially qualified him to deal.

At the first meeting of the Session after the opening meeting Mr. W. Worby Beaumont brought to a later date the history of Mechanical Road Carriages, with which history he had previously dealt in a course of Cantor lectures. At a later period of the Session Sir David Salomons dealt with another portion of the same subject in his paper on "Motor Traffic." The rapid advance in this description of locomotion which was anticipated on the passing of the Locomotives on Highways Bill at the end of last Session, has not been achieved; but the subject has lost none of its interest, and probably in the long run the ultimate type of motor carriage will gain by the delay in perfecting it. The rival type of mechanical road carriage—the cycle—was in existence and even popular for a long time before it achieved its present perfection. The steps by which this perfection was reached formed the subject of a paper by Mr. George Lacy Hillier, who showed how many and what diverse attempts had been made before the modern type of safety bicycle was eventually adopted.

The older form of locomotive traffic, that on railways, received this session a certain amount of attention, for Mr. Calthrop gave the Society a very full and valuable account of the Barsi light gauge railway, which may be taken as the best instance in existence of a thoroughly equipped light railway, and would serve extremely well as a model for any railways of a similar character which may be constructed in this country. Mr. Black's paper on "The Railway to India" dealt not with any particular type of railway, but on the route which the railway, no doubt, sooner or later to be built, from Europe to India will have to take.

Mr. Black favours a scheme from Cairo across the isthmus of Suez, thence across Arabia to the head of the Persian Gulf, and by the eastern shore of the gulf to Kurrachee.

The Society has not of late years had many papers on shipbuilding. The roller boat of Monsieur Bazin, which was described in Monsieur Emile Gautier's paper, is an entirely new departure, the success of which has yet to be demonstrated. It was hoped that we might have seen the boat over in this country, but up to the present time she has made no attempt to cross the Channel.

Two papers dealt with electrical subjects. One by Mr. Frederick Bathurst on "The Prevention of Fires due to the Leakage of Electricity." This was the result of the offer of a prize under the Fothergill Trust for an essay on the subject—an offer which was certainly successful in bringing forward a useful contribution. The other electrical paper was by Mr. W. B. Esson, on "The Transmission of Power by Alternating Currents"—a subject of very considerable importance if electricity, now so universally distributed in our cities for lighting, is also to be employed for power purposes.

Early in the Session, Mr. Bennett H. Brough, who in 1892 gave the Society a valuable course of lectures on "Mine Surveying," read a paper on "Mining at Great Depths." He stated very clearly the conditions to be met with in such mining, and gave a useful record of the depths which have up to the present been reached. The conclusion to be drawn from Mr. Brough's paper is that it would be possible to carry mines to a depth considerably lower than was generally believed to be possible or economical. Another paper dealing with a mining subject was that of Mr. Robert H. Jones, who described the very remarkable discovery of what may be considered a new and cheaper form of asbestos recently developed in Canada.

The supply of London water is another matter which may be classed among those of an engineering nature. In his paper on this subject, Dr. Percy Frankland took the opportunity to defend the London water supply from the aspersions which have lately been cast upon it, and argued that the results of bacteriological investigation showed that the London water was practically pure, and was not liable to the condemnation which has so very frequently been passed upon it.

Two papers dealt with more or less agricultural subjects. Mr. George Gordon drew attention to the neglect of English orchards, and gave the results of an extended investigation into their condition which he has lately been making. There seems, unfortunately, little reason to doubt the accuracy of Mr. Gordon's conclusions, and it is hoped that the attention he has drawn to the matter in his paper and elsewhere may have some good effect. The second paper under this head was that by Mr. M. J. R. Dunstan, on "Dairy Produce and Milk Supply." Mr. Dunstan discussed somewhat fully the question of co-operation in the treatment of dairy supplies, and pointed out under what conditions creameries might be established with a probability of success, and he also showed that there were many difficulties in the wholesale establishment of factories. On the whole, Mr. Dunstan concluded that a general factory system would not be successful, though there was room for a limited number of such factories.

Another paper dealing with the question of food supplies was that by Mr. David Crole on the "Chemistry of Tea"—a paper which formed a useful supplement to the many communications which have been at different times before the Society on the growth and manufacture of tea.

There were three papers which dealt with subjects of an economical character. Mr. W. A. S. Hewins dealt generally with "The Teaching of Economics"—a subject in which teaching has only been supplied in London within a very recent date by the establishment of the London School of Economics. The Right Hon. Horace Plunkett gave an account of "The Recommendations of the Recess Committee for the Development of the Industrial Resources of Ireland;" and at the last meeting of the Session, Mr. Moreton Frewen produced an animated discussion by his treatment of the Silver Question.

Three papers were devoted to Music. Mr. Arnold Dolmetsch gave a paper on "The Chamber Music of Purcell, Handel, and Bach," with illustrations on the instruments for which the music was written—the harpsichord, the clavichord, the viola, the viola da gamba, and the violin. Mr. William Nicholl gave some practical suggestions on "Voice Production"—a subject of which he has made a special study; and Mr. Spencer Curwen gave a short sketch of the condition of "Music in London at the Queen's Accession."

The recent progress which has been made in the attainment by various photographic methods of the reproduction of colour gave an opportunity to Sir Henry Wood, the Secretary of the Society, of reading a paper on the subject, which was very fully illustrated by examples of nearly all the various methods by which colour has been more or less mechanically reproduced by photographic means.

II.—INDIAN SECTION.

In the Indian Section the papers were of more than average excellence, and the meetings were largely attended. Mr. William Lee-Warner who, in 1894, read a remarkable paper on "The Roman and British Indian Systems of Government," appropriately opened the session with an equally valuable and weighty paper, in which he indicated and explained the beneficial influences that have, during her Majesty's long reign, to some extent ameliorated the condition of the peoples of India, raised their level of moral welfare, and improved their conception of duty to each other. He specially dealt with a previously neglected topic, namely, the abolition, within a few years of the Queen's accession, of Indian slavery. In a paper read during his recent official mission to England, Professor Jagadis Chunder Bose, of the Bengal Education Department, offered various useful suggestions for the promotion of physical research in India, by means of which it is hoped that Indian industries may be extended, and Indian youths of University training provided with additional much needed fields of occupation. The third paper of the series was that of Sir Charles Alfred Elliott on the Indian Famine. As the chairman on the occasion, Lord George Hamilton, pointed out, the late Lieutenant-Governor of Bengal is probably the highest authority on famine administration, and the Society is greatly indebted to Sir C. Elliott for his lucid and exhaustive paper.

The prospects of ramie or rhea and the possibility of that fibre leading in the near future to the establishment of a new industry on a great scale have recently attracted unusual attention. In an excellent paper discussing the question mainly from a commercial and practical point of view, Mr. Barraclough maintained that the present position of the industry would justify an extended production of the fibre wherever suitable soil exists. Much valuable information was given by Mr. Michael Francis O'Dwyer in a paper admirably describing the journey he made last year to Bokhara, Samarcand, and Tashkent. His route was almost the same as that traversed by the Right Hon. G. N. Curzon, M.P., eight years ago, and Mr. O'Dwyer's ably-written narrative, giving the latest particulars as to the progress of Russian administration in the Khanates, is a welcome supplement to the former's well-known work, "Russia in Central Asia." Sir George Scott Robertson, well-known for his share in the heroic defence of Chitral, read an interesting and picturesque paper on what Lord Roberts of Kandahar (who presided) styled "that strange unknown country called Kafiristan," which has lately lost its independence and is now under the rule of the Amir of Afghanistan. A carefully-prepared and instructive paper on "Kerman and Persian Baluchistan, with special reference to the journeys of Alexander the Great and Marco Polo," by Captain P. Molesworth Sykes, British Consul at Kerman, terminated the session. As in the three preceding years, three of the meetings were held at the Imperial Institute, being open to Fellows of the Institute as well as to Members of the Society.

III.—FOREIGN AND COLONIAL SECTION.

The opening meeting of this Section was held on February 2nd, when Sir Charles Dilke read a paper descriptive of the development of the British-Colonial Empire during the past sixty years of Her Majesty's reign, Mr. J. C. Colmer gave a similar account of Canada, at the meeting on February 16th, and drew interesting contrasts between the condition of the Dominion in 1837 and the present day. A like task was undertaken by Mr. James Bonwick at the meeting on March 16th, in relation to the Australasian Colonies. On April 6th, Mr. C. E. Fripp read a paper on the subject of his travels through Rhodesia and British Bechuanaland, in which he described his experiences during the recent native uprisings. At the last meeting, on May 4th, Mr. Aubyn Trevor-Battye read a paper descriptive of Arctic and Antarctic exploration, with special reference to his recent journey through Spitzbergen, and to the projected expedition to the South Polar regions.

IV.—APPLIED ART SECTION.

At the first meeting of the Section, on January 26th, Mr. W. H. St. John Hope read a valuable paper on "The Artistic Treatment of Heraldry," in which he showed how effectively heraldic subjects were treated by architects and designers of a former age, when heraldry was a living art. The paper was illustrated by a fine series of lantern slides of the various applications of heraldry from the 13th century, showing how it was used on seals, armour, clothing, and in architecture.

On February 9th, Mr. George McCulloch described the progress of "Lithography as a Mode of Artistic Expression," and at this meeting a remarkable historical collection of artistic lithographs was shown, as well as specimens of the work of living artists—Sir J. D. Linton, Messrs. McCulloch, Pennell, Ravenhill, Strang, Way, Whistler, &c. Mr. T. R. Way demonstrated the process of lithography, and transferred to stone a drawing made on transfer paper. At the third meeting Mr. Matthew Webb gave an interesting demonstration of the mode of working in Gesso, and fully described the technique of this beautiful art, and the materials necessary for carrying it out successfully.

Mr. W. R. Lethaby read a paper on "Artistic Lead Work," on March 30, in which he gave an instructive account of the fine examples to be found in various parts of the country, and of the attempts which have been made to restore lead to its proper position as an artistic material. Mr. Lethaby's paper forms an excellent appendix to his important work in the same subject published in 1893.

Dr. J. W. L. Glaisher, F.R.S., at the meeting of April 27th, traced the history of Delft ware from its inception in the little Dutch town of Delft to the end of its fabrication, and also described the similar ware produced at Rouen, Nevers, and other places. The paper was fully illustrated by a series of specimens selected from Dr. Glaisher's own collection, and by some specially fine examples from the South Kensington Museum, kindly lent by the Science and Art Department.

The last paper of the Session was by Mr. Clulow, on "A Half-Century of Line Engraving—1780-1830," and at this meeting were shown on the screen a series of enlargements of the minute and beautiful engravings from the drawings of Stothard, Turner, &c., by the Heaths, the Findens, Goodall, Shenton, Robinson, &c., produced for the Annuals and such finely illustrated books as Rogers's "Poems" and "Italy." Although these engravings were drawn on a very small scale, the enlargements did not suffer as designs. Mr. Clulow concluded his paper with the hope that the beautiful art of copper-plate engraving may again flourish.

V.—CANTOR LECTURES.

The first course of Cantor Lectures for the past session was delivered by Professor Vivian B. Lewes; his subject being: "The Use of Gas for Domestic Lighting." Professor Lewes gave an account of the many recent developments of methods for obtaining improved illumination from gas, methods which have been so greatly stimulated by the introduction of electric light. He also described the various methods of gaseous illumination depending upon other materials than coal gas, including the new material acetylene, the advantages of which he described, while giving a warning against its careless or ignorant application.

The second was by Mr. William Burton on "Material and Design in Pottery." Mr. Burton's four lectures were devoted to simple earthenware, faïence and fine earthenware, stonewares, and porcelaln. In all of these different classes of pottery he showed how character and design were alike dependent upon material and decoration, in accordance with the characteristics of which it had been principally orignated, developed and modified.

"The Industrial Uses of Cellulose" formed the subject of the third course of lectures, which was given by Mr. C. F. Cross. While cellulose is one of the oldest materials of human manufacture, it is also one of those in which the most recent development has been made, including, as it does, the manufacture of paper, the production of artificial silk, and smokeless powders.

Prof. Roberts-Austen's course on "Alloys" is the fourth series which he has delivered on the subject, so that the Society has had the benefit, from time to time, of following the full course of the very remarkable series of investigations which he has made—a series which, it is to be hoped, will before long appear in a complete form. The effect of various proportions of the constituent metals on the point of solidification, the diffusion of solid and liquid metals, and the investigation into the composition of steel and cast iron were among the more important points dealt with in the course.

The last course of lectures was given by Mr. Lewis Foreman Day, his title being "Design in Lettering." The series dealt with the character of printed letters, and the treatment of the alphabet for ornamental and decorative purposes.

VI.—HOWARD LECTURES.

From time to time the Council have used the funds available under the Howard Trust for the provision of a course of lectures. This bequest was left to the Society, in 1872, for the periodical award of a prize for an essay on steam, or other motive power, or for an invention connected therewith. In offering the premium to a selected writer, the Council made it a condition that the essay should take the form of a course of lectures, which might afterwards be published. By this means, two very useful text-books have been provided in former years—one by Sir William Anderson on "The Conversion of Heat into Useful Work," and one by Professor Cawthorne Unwin on "The Development and Transmission of Power from Central Stations." The course which, at the request of the Council, Professor James A. Ewing delivered during the Session on "The Mechanical Production of Cold," will, in their opinion, be of no less value than its predecessors. The subject was treated in a very full and complete way. Dealing first with general principles, the lecturer passed on to treat separately the several types of machines employed. He then, after referring to methods of testings, proceeded to the various and very numerous industrial applications, including cold storage, transport, ice-making, ice rinks, &c., and finished with some remarks on the production of very low temperatures.

VII.—JUVENILE LECTURES.

The subject of the Juvenile lectures this year was "The Growth and Demolition of Mountains," and the lecturer, Mr. Clinton T. Dent. The greater part of the two lectures was devoted rather to the demolition than to the growth of mountain ranges, and Mr. Dent showed by various experiments how the mountains were being continually worn away on the one hand by the slow destructive agencies of water, heat and cold, and chemical action; and on the other by the more rapid effects of avalanches, glaciers, &c.

VIII.—ALBERT MEDAL.

The Albert Medal for the present year has been awarded, with the approval of H.R.H. The Prince of Wales, the President of the Society, to Mr. George James Symons, F.R.S., "for the services he has rendered to the United Kingdom by affording to engineers engaged in the water supply and the sewage of towns a trustworthy basis for their work, by establishing and carrying on for nearly forty years (now at over 3,000 stations) systematic observations of the rainfall of the British Isles, and by recording, tabulating, and graphically indicating the results of these observations in the annual volumes published by himself." A very full account of Mr. Symons's laborious work will be found in the paper which he read before the Society three years ago (in March, 1894) on "British Rainfall Records." The value of them Sir Frederick Bramwell stated at the time had been estimated by a competent authority as having saved the country from £15,000 to £20,000 a year. In 1860 Mr. Symons began by publishing a summary of the rainfall of 1859, collected from about 100 records, and this led him to form a regular organisation for observing and recording the rainfall day by day in different parts of the country. This organisation, which in 1860 was composed of 168 observers in England alone, now includes over 3,000 observers, scattered over all parts of the British Isles. In addition to this recording the rainfall of recent times Mr. Symons has collected and classified all the previous existing records, so that all the available information since 1677 is now arranged and available at a moment's notice.

At first starting the British Association provided a small grant, to be expended in the purchase of instruments and the tabulation of old observations, but this is the only pecuniary assistance Mr. Symons and his army of volunteer recorders have ever received. The value to engineers of his records is unquestioned. Testimony has been borne to it over and over again. Not only is the information contained in "British Rainfall" relied on by all engineers as a safe guide in the construction of works for water supply, but it governs the dimensions of sewers and their construction, since it is by considerations of the amount of daily rainfall, and of the maximum amount of storm-water to be dealt with, that the engineer estimates the size of his sewers, and decides on the manner in which the volume of water is to be dealt with, whether by pumping, by overflows, or otherwise.

No better illustration could be suggested of the value of patient statistical labour, nor would it be easy to find another similar case, in which the long and laborious collection of statistical facts, has produced such useful and such practical results.

IX.—MEDALS.

The Council have awarded the Society's Silver Medal to the following readers of Papers during the Session 1896-97.

At the Ordinary Meetings:—

To BENNETT H. BROUGH, Assoc.R.S.M., for his paper on "Mining at Great Depths."

To THE RIGHT HON. HORACE PLUNKETT, M.P., for his paper on "The Recommendations of the

Recess Committee for the Development of Ireland's Industrial Resources."

To EVERARD R. CALTHORP, for his paper on "The Barsi 2 ft. 6 in. gauge Light Railway."

To W. B. ESSON, M.Inst.C.E., for his paper on "The Transmission of Power by Alternating Electric Currents."

To M. J. R. DUNSTAN, M.A., F.R.S.E., for his paper on "Dairy Produce and Milk Supply."

To ROBERT H. JONES, for his paper on "Asbestos and Asbestic."

To PERCY F. FRANKLAND, Ph.D., F.R.S., for his paper on "London Water Supply."

In the Indian Section :—

To SIR CHARLES ALFRED ELLIOTT, K.C.S.I., for his paper on "Measures taken by Government for the Prevention of Famine in India."

To MICHAEL FRANCIS O'DWYER, I.C.S., for his paper on "A Visit to Russian Central Asia."

To SIR GEORGE SCOTT ROBERTSON, K.C.S.I., for his paper on "Kafiristan: its Manners and Customs."

To CAPTAIN P. MOLESWORTH SYKES, for his paper on "Kerman and Persian Baluchistan, with special reference to the journeys of Alexander the Great and Marco Polo."

In the Foreign and Colonial Section :—

To the RIGHT HON. SIR CHARLES DILKE, BART., M.P., for his paper on "The Progress of the British Colonial Empire during the Sixty Years of Her Majesty's Reign."

To JOSEPH G. COLMER, C.M.G., for his paper on "The Progress of Canada during the Sixty Years of Her Majesty's Reign."

In the Applied Art Section :—

To W. H. ST. JOHN HOPE, M.A., for his paper on "The Artistic Treatment of Heraldry."

To MATTHEW WEBB, for his paper on "Gesso."

To J. W. L. GLASHIER, D.Sc., F.R.S., for his paper on "Delft Ware."

They also passed a vote of thanks to SIR HENRY TRUEMAN WOOD, M.A., the Secretary of the Society, for his paper on "Reproduction of Colour by Photographic Methods."

X.—OWEN JONES PRIZES.

These prizes have now been awarded annually for 20 years, the first award having been made in 1878. The Council of the Society of Arts are trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of subscriptions to that fund, upon condition of their expending the interest thereof in prizes to "Students of the Schools of Art who, in actual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were awarded this Session, each prize consisting of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The list of the successful candidates was given in the *Journal*.[*]

The next award will be made this summer, on the result of the present year's examinations. Six prizes have again been offered for competition.

XI.—MULREADY PRIZE.

After the death of Mulready, in 1863, a fund was formed to establish a memorial to him. Sir Henry Cole was treasurer of this fund. The greater part of it was expended in erecting a monument over Mulready's grave in Kensal-green Cemetery. The balance, £109, was presented to the Society of Arts with the view of a Mulready Medal being presented occasionally to the student who should exhibit the best drawing from the nude at the usual examinations of the Department.

The Medal has been awarded on several occasions, the last occasion being in 1893. It was now offered again for competition amongst students of Schools of Art in the United Kingdom, at the annual competition to be held this year. The Science and Art Department undertook that its examiners should make the award, and, last November, two names were sent in as equal in merit. The Council, therefore, divided the value of the gold medal offered (£20) between the two candidates, and presented them each with a silver medal.[†]

XII.—PRIZE FOR INDUSTRIAL HYGIENE.

Mr. Benjamin Shaw, who died in 1887, presented to the Society a sum of £133 6s. 8d. Consols with the view of founding a prize of £20 to be given for Industrial Hygiene every five years. Though it has been offered several times, it has only twice been awarded.

The medal, under the conditions laid down by the testator, is to be given "For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means."

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[*] See *Journal*, August 2, 1896, vol. xliv., p. 769.

[†] The names of the prize winners, and the conditions of the competition are given in the *Journal*, November 6, 1896, vol. xliv., p. 898.

The prize was offered last year under the specified conditions, and was awarded to Messrs. Oakes and Leigh, of Willow-street, Burnley, for their improved shuttle guard.

The judges to whom the matter had been referred by the Council, reported that their guard appeared to provide, at a moderate cost, an important security which might previously have been obtained at a practically prohibitive price by means of former inventions.*

XIII.—FOTHERGILL PRIZE.

The Fothergill prize dates from 1821, £388 having been left by Dr. Fothergill to be awarded in medals or premiums for promoting useful arts. In the bequest the testator suggested for consideration certain objects, all relating to the prevention of fire, and the Council have thought it desirable that the prize should occasionally be offered for purposes consonant with the desires of the testator, as expressed in his will. They, therefore, offered a prize of £25 and a silver medal for an essay or paper on "The Best Means of Effectually Preventing the Leakage of Current to Earth in Electrical Installations from Generating Heat and Setting Buildings on Fire." It was proposed that the paper, if suitable, should be read and discussed at one of the Society's ordinary meetings.

A number of essays were sent in and from them the judges appointed by the Council selected the one by Frederick Bathurst, Assoc. Inst.E.E. The prize was therefore awarded to this paper, which was read at a meeting of the Society on Wednesday, March 10.†

XIV.—STOCK PRIZE.

In 1871 John Stock left £100 Consols to the Society, with the condition that the interest should be applied for the promotion of drawing, sculpture, and architecture. From time to time, as the accumulated funds permitted, prizes have been awarded under this head, the last award having been made in 1893. A Gold Medal, or a prize of £20, was offered‡ for competition among the students of the Schools of Art at the annual competition of 1897. The prize is offered for the best original design for an architectural decoration suitable for the interior of a building.

The Council believe that the prize can be more usefully applied by restricting the competition to Schools of Art than by offering it generally, without restrictions, it having been found in practice that, when a general offer was made, without any limits whatever, the competition was extremely small, and the results unsatisfactory. As in the case of the Owen Jones and Mulready prizes, the Science and Art Department have undertaken that their examiners shall make the award. The result will be announced in the *Journal* as soon as the Examiners have reported.

XV.—PRIZES FOR DRAWING.

Since 1889, the Council have placed at the disposal of the Royal Drawing Society, for competition among the candidates at its annual examination, 12 Bronze Medals, and, as usual, these medals were awarded for drawings sent in by students to the exhibition held by the Drawing Society in April last.

XVI.—EXAMINATIONS.

The number of candidates entering for the Society's Examinations show a very large increase on last year, though the difference between this and last year's numbers is not quite so great as the difference between those of the last year and those of the previous year. This year 6,919 candidates worked 7,513 papers, the number of candidates being 808 in excess of last year, and the number of papers worked 945. The numbers entered during the past eight years are given in the following Table :—

Year.	No. of Candidates.	No. of Papers worked.	No. of Centres.	No. of Subjects.
1890........	2,315	2,474	79	14
1891........	2,460	2,667	78	14
1892........	*2,928	3,143	96	13
1893........	3,702	3,916	109	13
1894........	4,106	4,376	131	14
1895........	4,777	5,108	146	14
1896........	6,111	6,568	197	16
1897........	6,919	7,513	221	19

* Total, with supplementary autumn examination, 3,351.

So far as can be judged, the average quality of the candidates is not very different from those of recent years, but the tendency is certainly downward rather than upward. The percentage of first-class certificates, which last year was 10·5, is now 8·8; but the per-centage

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[*] The announcement appeared in the *Journal*, April 2, 1897, vol. xlv., p. 423.

[†] See *Journal*, March 12, 1897, xlv., p. 331.

[‡] Particulars of the offer will be found in the *Journal* for October 16, 1896, vol. xliv., p. 869.

of failures has fallen from 21 in 1895, and 20 in 1896, to 19·8 in the present year.

There are only six subjects in which a decrease in numbers is shown:—Arithmetic, 191, as compared with 239 last year; English, 175, as against 206; Commercial Geography, 62, against 88; Spanish, 85, against 111; Portuguese, 14, against 22; Domestic Economy, 185, against 256. The number of candidates for Precis-writing was the same as last year, year, namely, 18. All the other subjects show an increase. In Book-keeping there are 3,435 against 3,008; Shorthand, 1,559, against 1,272; Type-writing, 337, against 262; Economics, 23, against 21; French, 327, against 324; German, 211, against 203; Italian, 25, against 20; Rudiments of Music, 402, against 352; Harmony, 190, against 186. It must also be noted that three new subjects have been added—Elementary French (191 candidates), Elementary German (61 candidates), and Elementary Spanish (22 candidates).

The Council rely, for the conduct of these examinations, entirely upon the local committees who undertake the work; but it was thought that the work of the committees would be facilitated, and at the same time that the Council would obtain valuable information as to the manner in which the examinations were carried out, if some system of inspection could be arranged for. As the Society has neither the organisation nor the funds for a system of its own, the Council applied to the Department of Science and Art and asked whether permission could be granted for some of their inspectors to visit the examination centres while the examinations were going on, and report on what they saw there, in the same way as they report to the Department. The permission was granted, and many of the inspectors kindly undertook the work at a nominal fee. In all, it was found possible to utilise the services of fourteen of these gentlemen, who visited amongst them 80 centres, of which 39 were in London and 41 in the provinces. To these 80 centres, 105 visits were paid.

As regards the manner in which the regulations are carried out, the report is extremely satisfactory. Very few irregularities were reported, and even of these it may be said that they were all of a trifling character. Several useful suggestions were made, having regard generally to local requirements, and the attention of the local committees was drawn to them. The Council are greatly indebted to the Department, and to the gentlemen who very kindly undertook the work and carried it out in a most efficient manner. It unfortunately happened that at many important centres of examination, the services of the Department's inspectors were not available; but if the experiment is repeated next year, it is hoped that arrangements may be made for the inspection of those centres which could not be dealt with at the last examination.

The examiner in Arithmetic remarks that this year's papers presented the same characteristics as those of last year, a falling off in the number of the best papers, and an increase in the number of inferior papers. There were, however, some papers of a very high class, and the papers of the medallists were in marked contrast to the imperfect attempts of the many who failed. It is evident that those who fail take no notice of the reports of former years; the same mistakes are repeated year after year. It is worth while reminding candidates that some valuable remarks on the paper of each year will be found in the programme of examinations, and it is desirable that they should study these in connection with the papers for past years if they wish to achieve success in future. The numbers in this subject, which last year showed a distinct increase, have again fallen, and, having regard to its important nature, this is distinctly a matter for regret. Arithmetic is, unfortunately, not one of the subjects scheduled by the Science and Art Department as a technical one, and therefore students are not encouraged to enter for it.

The examiner in English reports that the papers this year evince a fair, though not a high, standard of merit. The number of those entitled to be placed in the first-class is not so high as could be desired. He lays much stress on the necessity for accuracy, and draws the attention of teachers as well as candidates to this point. That the numbers should show a decrease in this subject is a matter for regret. English, like arithmetic, suffers from not being considered "technical."

Book-keeping still remains the most popular subject, and it is in book-keeping that the largest increase in numbers has taken place; but, as in other subjects, the quality does not keep pace with the numbers. The percentage of candidates who have attained to first-class is 9·14, whereas the average for the preceding ten years is 13; 9·43 per cent. have failed, the average for the preceding ten years being 8·82. Not only is the proportion of first-class low, but the internal standard of quality among the papers is, in the opinion of the examiner, not very satisfactory.

The examiner attributes the decline in quality to the want of frequent preliminary tests, and to the lack of practice in examinations.

The examiner in Commercial Geography thinks that the work done was in several respects more satisfactory than in former years. The geography of Africa was almost uniformly well done, but the general questions were badly answered. Candidates and teachers ought to understand that the special subject prescribed is not the exclusive subject of the examination.

The examiner in Shorthand reports that the general work may be regarded as a fair average. The paper, he considers, was a little more difficult than usual, but allowance was made for this in adjudicating the marks. The examiner points out that some of the candidates failed by being too ambitious and trying for a first-class, instead of being content with a lower grade, in which they might reasonably have expected to succeed.

The examiner in Type-writing remarks that, though the number of first-class papers was favourable, she had never had so many mediocre and positively bad sets of papers submitted at any previous examination. She impresses upon intending candidates the necessity of availing themselves of any facilities of going in for school or association local examinations as a preliminary training.

The examiner in Economics considers that the papers on the whole were better than last year; but many of the candidates stumbled at even quite elementary questions, and the knowledge of English economic history displayed by the candidates was, with few exceptions, meagre and inaccurate.

The examiner in Precis-writing thinks that the work done this year was better than that of last year. Most of the candidates were able to furnish a reasonable good abstract of each of the various letters given, but few of them were able to put the substance of the correspondence, as a whole, into a form at once intelligible and comprehensive.

The examiner in French considers that the proportion of higher class candidates contrasts favourably with the results of previous years; but he repeats the suggestion made on previous occasions that greater attention should be paid by candidates to the suggestions and recommendations in the syllabus issued for the subject. He considers that the results of the elementary examination justifies its establishment.

The examiner in German considers the general result of the examination more satisfactory than in former years. Most of the candidates gave evidence of a satisfactory knowledge of the language. The examiner also speaks well of the results of the elementary examination.

The examiner in Italian is well satisfied with the work of the candidates who presented themselves, and finds more evidence of attention to the study of translation into Italian.

The examiner in Spanish remarks that the majority of the papers showed a very fair knowledge of Spanish, and this year there is an improvement in the translation of English into Spanish, which in former years was one of the weak points. On the whole it appears that the teaching of commercial Spanish is progressing favourably.

The examiner in Portuguese is, on the whole, satisfied with the work sent in; but thinks that sufficient attention has not been paid by candidates to the instructions contained in the syllabus, and to the remarks which he has made in previous reports.

In Domestic Economy the examiner finds the standard definitely higher than on former occasions, and thinks she can see evidence of very greatly improved instruction, as compared with that given in earlier days. The papers recommended for medals are of a very high degree of excellence.

The examiner in Music speaks well of the papers which were sent in, both in harmony and in rudiments of music, though in the latter subject it was evident that many of the candidates had not been at all well prepared for the examination.

XVII.—PRACTICAL EXAMINATIONS IN MUSIC, 1896.

The practical examinations in Music for 1896 were not concluded until the 1st July, too late for the results to be included in the last Report of the Council.

Some modifications were introduced in the system of examination, in the hope of attracting a higher class of candidates than in previous years. Candidates were asked to select for themselves which of four standards they chose to be examined in. Standard I. is easy, Standard II. moderately difficult, Standard III. difficult, and Standard IV. very difficult. For each standard a list of music was given, and a selection from this list was sent to the candidates six weeks previous to the examination. Candidates were expected to play or sing pieces from the selected list, as well as to play a piece, or a portion of a piece, at sight.

In all 365 candidates entered, a slight falling off from the number in 1895 (390), but not so large a decrease as might have been expected under the new and more difficult conditions. Of these candidates 11 took up two subjects, so that there were 376 examinations. Of these there were 330 passes and 46 failures. The following were the subjects taken up:—Piano, singing, violin, viola, mandolin, and organ. 258 entered for the piano, of whom 217 passed and 8 obtained medals; 58 entered for the violin, of whom 54 passed and 7 obtained medals; 1 took a medal for the viola; 1 passed with the mandolin; 9 entered and all passed for the organ, 1 taking a medal; 49 entered for singing and all but 1 passed, 2 obtaining medals.

Mr. John Farmer, of Balliol College, Oxford, and Director of the Harrow Music School, acted as Examiner, Mr. Ernest Walker, M.A., Mus.Bac. Oxon., and Mr. Burnham Horner, as Assistant-Examiners.

XVIII.—PRACTICAL EXAMINATIONS IN MUSIC, 1897.

The Practical Examinations for the present year have not yet been concluded. They were, in consequence of her Majesty's Jubilee, postponed to a week later than the date originally fixed. No alterations in the system adopted last year have been made. As soon as they are finished, a summary of the results will be given in the *Journal*. The number of candidates is 400.

XIX.—INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

In the month of January last, a suggestion was made to the Council of the Society of Arts that the Society should invite the Congrès International de l'Enseignement Technique to hold its fourth meeting in London, the three previous meetings of the Congress, since its foundation in 1886, having been held in France. It would not have been in accordance with the usual practice of the Government itself to issue an invitation for a meeting of this sort, but the Council were given to understand that Her Majesty's Government would generally assist the Congress, though they could not undertake to provide funds for its support. The Council felt that the Society itself could not afford to devote any funds to the purpose, and they therefore made application to some of the City guilds, asking whether they would consent to be associated with the Society in an invitation to the Congress, and would subscribe the necessary amount of money. This invitation was very liberally responded to, and eventually nine of the City Companies, namely, the Mercers, Drapers, Fishmongers, Goldsmiths, Merchant Taylors, Vintners, Clothworkers, Leathersellers, and Carpenters, joined in the movement, and contributed to the expenses.

As soon as the Council were satisfied that the necessary expenditure would be provided for, and that they might feel assured of the goodwill of the Education Department, and the Science and Art Department, they addressed a formal invitation to the Congress asking them to hold their meeting in London in June, that being about the date which the Committee of the Congress had decided upon as being the most convenient, with the idea that the meeting should be held at a time when the educational institutions of the country were not in vacation. The invitation was accepted, and the Council then applied to the Foreign Office asking that formal invitations might be sent to Foreign Governments requesting them to nominate delegates to the Congress. The Foreign Office at once acceded to the application, and the proper invitations were sent out through Her Majesty's representatives abroad. In response to this application the following delegates were nominated by their respective countries:—Mr. C. V. Brooks, by the United States of America; Mons. Eugene Rombaut, Mons. Paul Wauters, and Dr. O. Pyfferoen, by Belgium; Mons. Felix Martel and Mons. P. Jacquemart, by France; Mons. Boris Ovsianikoff and Mons. Gregory Wilenskin, by Russia. The extreme shortness of the notice given was doubtless a reason why the foreign delegates were not more numerous; but, under the circumstances, it cannot be regarded as other than satisfactory that so many were able to attend.

Invitations were also addressed through the Colonial and India Offices asking that representatives from the Colonies and India might be appointed, and an application was made to the Colonial Agents-General in London, asking if they would obtain communications on the subject of Technical Education in their respective colonies for the information of the Congress. Here, also, the notice was very short; but in many cases it happened that the information could be supplied without communication with the head office in the colony, and a number of valuable communications were received.

The Congress was opened at 11 o'clock on the 15th of June by an Address from the President, the Duke of Devonshire, K.G., and from the President of the last Congress, Monsieur le Professeur Leo Saignat. The meetings were held from the 15th to the 18th of June, inclusive, a morning and afternoon sitting being held on each day. The meetings were presided over by the Duke of Devonshire, Right Hon. Sir John Gorst, Monsieur Leo Saignat, Major-General Sir Owen Tudor Burne, Right Hon. A. J. Mundella, M.P., Mr. William Woodall, M,P., Lord Belhaven and Stenton, Sir John Donnelly, Sir Owen Roberts, Mr. W. Bousfield, Mr. J. W. Sugg, Sir Steuart Colvin Bayley.

In all, 56 communications were laid before the Congress. These included technical education and commercial education generally, technical education on its bearing on special trades, the technical education of women, technical education in India, and technical education in the colonies. The papers were all printed beforehand, and distributed at the meeting, for the purpose of facilitating discussion.

At the concluding meeting a permanent bureau was elected for the purpose of carrying on the work of the Congress in the interval between its meetings, the members consisting of most of those who had acted on the former bureau, with certain of the delegates who had been appointed by foreign Governments, and a number of English representatives.

The Lord Mayor was good enough to invite the Members of the Congress to a reception on the evening of Thursday, the 17th, and they were also invited to the Society of Arts *conversazione* on the 16th. On Saturday, the 19th, a small party of the foreign delegates and others visited Eton, where they were received by the Rev. Dr. Hornby, Provost of Eton, and after having been permitted to visit the State apartments of Windsor Castle, they went on to a garden party at the Royal Holloway College.

The Congress was very largely attended; 174 persons became Members of the Congress at a subscription of five shillings; while 197 delegates were nominated to represent various County Councils, universities, colleges, and other educational institutions of this country.

XX.—MEMORIAL TABLETS.

In the last report of the Council a full list was given of the houses on which memorial tablets have been erected. During the past year it has been decided to place a tablet on the house at Hampstead, known as Belmont, Rosslyn-hill, which was formerly the residence of Sir Harry Vane.

XXI.—CHICAGO EXHIBITION MEDALS.

When the Royal Commission for the Chicago Exhibition of 1893 was dissolved, the Council undertook to distribute the medals awarded to British exhibitors as soon as they were issued by the United States Government.

The medals and diplomas for the British Section were transmitted through Her Majesty's Ambassador at Washington to the Foreign Office, in June, 1896. Those intended for the British Colonies, with the exception of Canada, and for India, were sent over at the same time; and, in accordance with instructions received from the India Office and Colonial Office, the Indian diplomas and medals were handed over to the India Office; those for the self-governing Colonies to the Agents-General for the several Colonies; and those for the Crown Colonies to to the Crown Agents for the Colonies.

Those for the British Section were distributed to the exhibitors for whom they were intended. As there were certain discrepancies between the list of awards originally published and the list of medals actually issued, application was made through the agency of the Foreign Office for the rectification of these discrepancies, but up to the present the matter remains unsettled.

XXII.—ADDRESS TO HER MAJESTY.

In commemoration of the auspicious occasion of Her Majesty's Jubilee, the Council, on behalf of the Society, prepared an Address, which His Royal Highness the Prince of Wales, President of the Society, was graciously pleased to sign and present to her Majesty on behalf of the Society.*

XXIII.—LEASE OF SOCIETY'S PREMISES.

As the lease of the Society's premises, originally granted in 1863 for thirty years from 1867, expired at Lady-day, 1897, the Council have long had the matter of its renewal under consideration; and, after some negotiation with Mr. Drummond, the Society's landlord, it was agreed that the lease should be renewed as from Lady-day, 1896, for a period of eight years, terminating in 1904, at an annual rent of £600.

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* The Address appears on p. 715 of the present issue of the *Journal*.

XXIV.—HONORARY CORRESPONDING MEMBERS.

During the past year the Council have submitted to the members the names of a number of distinguished foreigners, eminent in various branches of arts, manufactures, and commerce, for election as foreign corresponding members.

XXV.—CONVERSAZIONE.

The Annual Conversazione of the Society was held on the 16th June, by permission of the Lords of the Committee of Council on Education, at the South Kensington Museum. The usual arrangements for the entertainment of visitors were made, and on this, as on many previous occasions, the Society are much indebted to the care and attention which was shown by the principal officials and the staff of the Museum in making the necessary preparations. The numbers present were 2,310, including many of the foreign delegates and others who were attending the meeting of the International Congress on Technical Education.

XXVI.—NEW COUNCIL.

In accordance with the Bye-laws, the Council have submitted to the meeting the balloting-list for the election of new members of Council. The Vice-Presidents retiring by seniority are Lord Kelvin, Sir Charles Malcolm Kennedy, Sir Stuart Knill, and Sir Saul Samuel. To fill their places, the Council propose Mr. R. Brundenell Carter, who retires from office as an ordinary member of Council; Sir John Donnelly, who retired last year at the expiration of his two years of service as Chairman of the Council; Sir Villiers Lister, who has acted on the Council more than once before; and Sir Donald A. Smith, the present High Commissioner for Canada.

The ordinary Members of Council retiring under the regulations are Sir J. Wolfe Barry, Mr. George L. Bristow, Mr. R. Brudenell Carter, and Sir Westby Perceval. In their places the Council propose Mr. Michael Carteighe, who has previously served a term of office on the Council; Mr. Lewis Foreman Day, who is known to the Society as an active member of the Applied Art Section, and as having given several courses of Cantor lectures on subjects connected with applied art; Sir Douglas Straight, whose Indian career and whose journalistic and literary experience are likely to render him a very useful member; and Mr. William Luson Thomas, who is well-known as one of the founders of the "Graphic" newspaper.

XXVII.—OBITUARY.

The Society has not had to deplore the loss of many distinguished members during the year just completed. Sir Benjamin Richardson was for a long time on the Council; he took a very active interest in the Society's work, and contributed some important series of lectures to its proceedings. He represented the Society as trustee of the Soane Museum from 1882 to the time of his death. Dr. Mouat was one of the earliest members of the Committee of the Indian Section and contributed to its proceedings. Dr. Child took an active part in the Society's Sanitary Conferences. Professor Sylvester was associated with the foundation of the Society's examinations; and Sir Wollaston Franks with the inauguration of exhibitions. Among the honorary corresponding members of the Society, Sir Ferdinand von Mueller, Dr. Fresenius, Dr. Steinheil, and Professor Ferrari passed away during the year.

Notices of most of the above, and of other members of the Society deceased, have already appeared in the *Journal*.

XXVIII.—FINANCE.

The annual statement of receipts and expenditure was published—in accordance with the usual practice—in the *Journal* last week. It shows the revenue and expenditure for the financial year ending May 31st last, the Assets and Liabilities of the Society, its Investments and the Trusts standing in its name.

The CHAIRMAN moved the adoption of the Report. He said he considered that the work of the past Session had been very successful, and he would like to draw the attention of the meeting to the Address of the Duke of Devonshire, delivered at the opening meeting of the International Congress on Technical Education, in which his Grace stated his opinion of the importance of the work done by the Society.

Mr. R. BRUDENELL CARTER, F.R.C.S., in seconding the adoption of the Report, said he wished to express the thanks of the Society to the City Companies for the very valuable assistance they had rendered the Society during the past year. It was one of the conditions of life in England that that which in many countries was done by Governmental authority had to be done in this country by private liberality or private enterprise, and had it not been for the magnificent liberality of the City companies, who came forward at very short notice, it would have been quite impossible for the Congress to have been held, or, if held, to have been conducted in the successful manner in which it had been conducted.

Mr. MARTIN WOOD said he thought it would be well if an alteration of the rules of the Society were made by which the annual meeting could be held in the evening. He considered that the evening meeting had been made more attractive by the increased number of illustrations which had been shown. He was glad to see the increased number of candidates entering for the Society's examinations, and thought the system of inspection an excellent measure, and he fully agreed with the remarks made about the effectiveness of the Society.

The adoption of the Report was then agreed to.

THE CHAIRMAN moved a vote of thanks to the Secretary and other Officers of the Society, including Mr. S. Digby and other secretaries of Sections, which was seconded by Sir GEORGE BIRDWOOD, and carried unanimously.

The SECRETARY, in returning thanks for this expression of confidence in himself, and in the other officers of the Society, referred to the fact that the present Session was the twenty-fifth of his own connection with the Society.

The ballot having remained open for one hour, and the Scrutineers having reported, the CHAIRMAN declared that the following had been elected to fill the several offices. The names in italics are those of members who have not, during the yast year, filled the office to which they have been elected:—

PRESIDENT.

H.R.H. the Prince of Wales.

VICE-PRESIDENTS.

H.R.H. the Duke of Saxe-Coburg and Gotha, K.G.
H.R.H. the Duke of York, K.G.
Sir Frederick Abel, Bart., K.C.B., D.C.L., D.Sc., F.R.S.
Duke of Abercorn, K.G., C.B.
Captain W. de W. Abney, C.B., F.R.S.
Sir W. Anderson, K.C.B., D.C.L., F.R.S.
The Attorney-General, G.C.M.G., Q.C., M.P.
Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D.
Sir Edward Birkbeck, Bart.
Sir Courtenay Boyle, K.C.B.
Sir Frederick Bramwell, Bart., D.C.L., F.R.S.
R. Brudenell Carter, F.R.C.S.
Right Hon. Viscount Cross, G.C.B.
Right Hon. George N. Curzon, M.P.
Major-General Sir John F. D. Donnelly, K.C.B.
Hon. Sir Charles W. Fremantle, K.C.B.
Sir Douglas Galton, K.C.B., D.C.L., F.R.S.
The Lord Chancellor.
Sir Villiers Lister, K.C.M.G.
William Henry Preece, C.B., F.R.S.
Prof. William Chandler Roberts-Austen, C.B., F.R.S.
Earl of Rosebery, K.G., K.T.
Sir Donald A. Smith, G.C.M.G., LL.D.

ORDINARY MEMBERS OF COUNCIL.

Sir Steuart Colvin Bayley, K.C.S.I., C.I.E.
Lord Belhaven & Stenton.
Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I.
Michael Carteighe.
Lewis Foreman Day.
Joseph G. Gordon.
Henry Graham Harris.
James Sewell Neville.
Alexander Siemens.
Sir Douglas Straight.
William Luson Thomas.
Professor John Millar Thomson, F.R.S.

TREASURERS.

B. Francis Cobb.
Sir Owen Roberts, M.A., D.C.L., F.S.A.

SECRETARY.

Sir Henry Trueman Wood, M.A.

TRUSTEE FOR SOANE MUSEUM.

Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D.

On the motion of the CHAIRMAN, seconded by Mr. J. G. GORDON, a vote of thanks was passed to the Scrutineers, which was carried unanimously.

Sir CHARLES W. FREMANTLE, K.C.B., proposed a cordial vote of thanks to the Chairman for his valuable services as Chairman of Council. They would agree with him that his duties this Session had been more arduous than usual.

The resolution was seconded by Mr. W. H. PREECE, C.B., and carried.

The CHAIRMAN acknowledged the vote of thanks, and the meeting then adjourned.

Miscellaneous.

THE TUSCAN STRAW HAT INDUSTRY.

According to a recent report of Mr. A. G. Linari, of the Consulate General at Florence, there is at the present time a very decided depression in the straw hat industry in Tuscany, and as a sign of this it may be mentioned that while some years ago in the district of San Miniato more than 12,000 sacks of seed for the growing of straw were sown per annum, in 1896 only 300 sacks were employed for that purpose. Moreover, the price paid for bleaching 12 straw plaits, which was formerly 2 lire 20c. (1s. 9d.) to 2 lire 70c. (2s. 2d.), is now reduced to from 1 lire 70c. (1s. 4½d.) to 2 lire (1s. 7d.), notwithstanding the adoption of a more expensive process of bleaching. The origin of manufacturing hats with wheat straw in the district of Florence is somewhat involved in obscurity. According to Cesare Cantù, a well known Italian historian, it can be traced as far back as the beginning of the 14th century, but his statement appears to be corroborated by no trustworthy data. It is, however, ascertained beyond doubt that in the year 1574 this industry was already of some importance. The original seat of the industry appears to have been Signa, a village near Florence, straw being imported at that date from abroad. In 1718 attempts were first made to grow the wheat in a particular way, in order to obtain a fine and white straw suitable for plaiting. These experiments having proved successful, the cultivation of straw gradually developed to a considerable extent, while straw plaiting became, on the other hand, more important and perfect. Once so started the manufacture of straw hats continued from 1765 to 1771 with unabated success, an important trade being carried on with England and other countries. About the year 1810 a certain Giuseppe Carbonari, a native of Leghorn, established himself at Signa, and introduced the manufacture of an improved broad-brimmed hat, called *fioretto*, which soon became very popular in France and Germany, and afterwards in England and America. In consequence of the increased demand from all parts of Europe, the manufacture spread from Signa and Brozzi to Sesto, Campi, Carmignano, and Prato, giving work to more than 60,000 hands, the average daily earnings being about 2 lire 50c. (2s.). In 1822, 80,000 hands were employed, the best of them earning 8 lire (6s. 5d. per diem). After 1826 the Florentine straw industry rapidly declined. By this time England began to manufacture with Florentine braids a description of hat which greatly met the favour of the English public, and easily supplanted the Florentine article on the English markets, thereby stopping all importation from Florence. In consequence of this competition many Florentine straw merchants suffered heavy losses, skilled hands emigrated, and great alarm arose among those interested for the future of an industry which was already considered as being on the very verge of ruin. It soon, however, received a fresh and vigorous start by the introduction of a new system of straw plaiting, viz., the 11 straw braids. These braids, made of 11 straws, or ends, were joined together so as to form by the combination of several narrow strips an extended sheet of plaited work. The hats manufactured with these braids soon found a ready sale on the foreign markets. In 1840 looms were first adopted for plaiting straw together with horsehair or silk on the Swiss system, the village of Fiesole becoming the centre of this new industry, and, shortly after, the employment of the lower part of the stalk of the wheat rather than the top was introduced, the innovation being followed by the invention of the celebrated *cappotte*, or Leghorn hat, made of 13 straw plaits. In consequence thereof the number of hands, which had temporarily diminished, soon increased, and surpassed the most prosperous periods of the industry. These *cappottes*, which had become known abroad under the title of Leghorn hats, owing to their being principally shipped at that port, had the very peculiar shape of a sugar-loaf, formed by 125 or 200 strips of braid, and cost from £16 to £20, and even as much as £33 each. Although some months may have been required to make a *cappotte* of large size, it is evident, considering the proportionately higher value of money at that time, that straw plaiting had then become a highly remunerative occupation. After the success of the *cappotte* attention was given to the introduction of new patterns for men's hats, as well as of presses for blocking them into shape, according to the exigencies of fashion in the different localities. This improvement gave a further impetus to production, which in 1870 reached the zenith of its prosperity in the district. The industry prospered until 1875, when, owing to a great crisis in North America, and to the success of Swiss, Chinese, and Japanese goods on European markets, there was a temporary depression. This was followed by a revival, which lasted several years, in spite of the still increasing competition of Switzerland, China, and Japan, but of late this competition has caused the Florentine industry to rapidly decline, and it is at present in a most depressed condition. The straw specially grown for plaiting is divided into two varieties of the common bearded wheat, viz., the *Triticum Oestivum*. It is only in certain areas that straw suitable for making plaits is produced. It must have a certain length between the knots, must possess a clear golden colour and not too brittle. After drawing, the straw is cut into lengths, dried in the sun, spread out for about a week to be bleached under the influence of sunlight and abundant dews at the end of July and August, and then collected into bundles called *manate*. After bleaching, straws are cleared of the outer sheath or leaf. A woman can prepare in this way from 140 to 200 *manate* per day of straw bents. The straw bents are afterwards bleached in sulphur fumes, and then sorted into various thicknesses by means of an apparatus called *sistola*, consisting of a series of sieves with spaces of a diameter varying from 0·8 to 3·0 millims. The subsequent operation is the *spigatura*, or removal of the ears from the straws, which was formerly done by cutting off the ears with ordinary scissors. Of late a special apparatus has been employed. After this comes the classification of straws according to their length. When straw has grown unequally, in which case it is termed *organata*, this classification is made in a greater number of lengths, from thirty to sixty, and more. The last operation in order to obtain the straw bents ready for use in the separation of the lower part called *pedale*, which in growing has been covered by the leaf, and is, consequently, the whiter portion of the straw, from the upper part which, having been exposed to the sun, is naturally of a darker colour. The latter is known in Italy under the name of *punta*, in English being commonly called

"Tuscan." The straw, after being so prepared is turned into plaits of numerous sizes, taking their name after the number of bents with which they are worked up as plaits of 7 or 11 bents. If formed of the lower part of the bent they are said to be *pedal* plaits, those made with the upper part being called *trecce di punta*. An important operation is the bleaching process that plaits must undergo before they are worked up into hats. In an official report upon this industry, it is stated that this bleaching, though much improved of late, is still inferior to that practised in other countries, more particularly that at Luton. Plaits bleached there maintain their whiteness in spite of time, while the Tuscan plaits, notwithstanding the recent system of using oxygenated water, soon turn into a whitish dirty colour tending to yellow. This is a great cause of inferiority of the Tuscan plaits which are preferably exported unbleached. On the other hand, according to a leading English merchant of Florence trading in that line, Italian bleaching has for a long time, and is to-day, much superior to English or any other bleaching.

THE PHILADELPHIA TEXTILE SCHOOL.

Among the institutions of Philadelphia is the Textile School, which for some years past has held a very high position, and is spoken of as having no rival, great or small, upon that side of the Atlantic. It was established in 1884, and to-day is recognised as being a model in its line. Her Majesty's Consul at Philadelphia states that for thirteen years this institution stood alone in the United States, and claims to have as creditable a record as any of the similar institutions in Europe. This school forms one department of the school of industrial art of the Pennsylvania Museum, which commenced in the year of the Centennial Exhibition (1876). The school at first was without the machinery, the apparatus, and even the teaching staff to give the necessary technical instruction, and everything was wanting which the charter, issued to the school, of the art industries of the State, called for. In 1882 the President of the Philadelphia Textile Association saw the advisability of making this a school to train students to the practical knowledge of textile industries, and therefore undertook to carry out the project. In course of time the sum of 30,000 dollars (£6,000) was obtained and placed at the disposal of the trustees, with which rooms were rented, teachers engaged, and a class of night students organised in 1884-85. In the following summer it was decided to erect an annex to the main school building for the special use of the textile department. The school has now a teaching staff of some fifteen men and women, among whom are instructors in chemistry and dyeing, in weaving, in Jacquard sketching and designing, in carding and spinning, design and colour harmony, in dry and in wet finishing. Further, there is a lecturer on Patent-law, and there are teachers of French, German, Italian, and Spanish. Two separate three-year courses are arranged for, the one for day classes, the other for evening classes, the first being necessarily more thorough than the second; also partial and special courses for students limited as to time. It is said that machinery valued at 50,000 dollars (£10,000) is now in rooms of the school, to which the students have free access.

CUBAN TOBACCO.

The export of cigars from Cuba in 1896 amounted to 185,914,000 against 156,513,000 in 1895, thus showing an increase for last year of 29,401,000, which is due chiefly to General Weyler's decree of May 16th, 1896, prohibiting the export, elsewhere than to Spain, of all leaf tobacco grown in the provinces of Havana (*partido* leaf) and Pinar del Rio (*Vuelta Abayo* leaf). In consequence of this, consumers of high-grade cigars abroad were compelled to buy the Havana-made article solely, instead of cigars made from the leaves exported abroad. The export of cigarettes, which is always smaller than the home consumption of these articles, has been the same as in previous years, but it is impossible to obtain the statistics of this branch of the tobacco trade. The British Vice-Consul at Havana says that the total export of all kinds of tobacco from Havana, including the *Vuelta Arriba* leaf, under which is comprised that of Remedios, Villa Clara, Yara, Gibara, and all districts east of Havana, amounts to 16,823,000 lbs. as against 30,466,000 lbs. in 1895. The decrease of 13,643,000 lbs. is, as before mentioned, due to General Weyler's decree. An average crop of tobacco in the island of Cuba is estimated to yield in Pinar del Rio, 260,000 bales; in Havana (Partido), 20,000; and Vuelta Arriba, 280,000 bales, making in all, 560,000 bales. Of this total, in normal years, about 220,000 bales are used in the cigar and cigarette manufactories of Havana, and about 338,000 bales for export. The average weight of one bale is computed at 110 lbs. net. The produce of the Pinar del Rio and Havana provinces amounts, under ordinary circumstances, to about 280,000 bales, but the past year has shown a decrease of about 70 per cent., caused by destruction by the Cuban insurgents, and the whole crop did not amount to more than 85,000 bales. Vice-Consul Gosling says that the prospective scarcity of tobacco in Cuba will probably cause the export of this article from Mexico and other tobacco-producing countries to increase, and though tobacco grown in these countries cannot compete with that produced in the provinces of Vuelta Abayo and Havana, there is always a good market for tobacco of inferior quality, such as that known in Cuba as "Vuelta Arriba," in Bremen, Hamburg, and Antwerp. There is now, therefore, an opportunity for countries where both soil and climate are favourable for the growth of the plant, to induce planters who are familiar with the cultivation of tobacco to make trials on a moderate scale, and to ship their produce to the markets offering the best prospects for a profitable sale, and these, as before-mentioned, are Bremen, Hamburg, and Antwerp. Consignments of tobacco are handled with great care at these ports, and the consignees, on the receipt of the first trial shipment, would then be able to point out to the planters any defects which may have appeared in the tobacco. In this manner, many of the British colonies in the West Indies, where the climate is suitable for tobacco culture, could gradually succeed in introducing tobacco of such quality as would meet with a ready sale in the above markets.

THE PRODUCTION OF INDIAN INK.

The province of Wuhu, in China, produces the celebrated Indian ink, more correctly called China ink, used by artists who paint in water colours. From Wuhu, it goes to every part of China and all over the world; in 1895, about two tons of it were exported to foreign countries from Shanghai, valued at £564. It may be made in other parts of China, but the best comes from Wuhu. Consul Fraser says that the materials from which this beautiful black ink is made are the following:—(1) Sesamum oil, colza oil or the oil expressed from the large poisonous seeds of what Dr. Brettschneider calls the *Dryandra Cordata*, or *Elæococco Verrucosa*, called by Chinese *Wu Tung*, a tree extensively cultivated in the Yangtsze Valley, and also well known in Japan; (2) varnish; (3) pork fat. The lampblack made by the combustion of these substances is classed according to the materials and the grade fineness, and also according to the time taken over the process of combustion. The paste made of this lampblack has some glue added, and is beaten on wooden anvils, with steel hammers. Two good hammerers can prepare in a day 80 pieces, each weighing half-a-pound. A certain quantity of musk (of the musk-deer), or of Baroos camphor, for scenting it, and gold leaves, are added; the latter, the quantity of which varies from 20 to 160 to the pound, being to give a metallic lustre. The materials thus prepared are moulded in moulds of carved wood, dried (which takes about 20 days in fine weather), and adorned with Chinese characters in gilding. About 30 or 32 average-sized sticks of ink go to the lb. The price varies from 2s. or less per lb. to as much as £7, there being over a dozen different grades. Nearly all writing is done by the natives throughout China, in Japan, Corea, Tonquin, and Annam, with this China ink, rubbed down on a stone ink-slab, and applied with a paint-brush of sable, fox or rabbit hair, set in a bamboo holder, and when not in use carefully covered with a protecting brass cap. The superior kinds of this ink appear to be used in China and are not exported.

Correspondence.

TECHNICAL EDUCATION CONGRESS.

As a member of the Society who attended the recent Congress held at the Society's rooms upon technical education, I would suggest as a means of further usefulness, that members of the Society should make known the fact in their various districts, by means of the local Press, and personal canvass among all friends of technical education, that the full report of the proceedings will shortly be obtainable. So valuable a contribution to the subject should be in the hands of all technical educational committees, teachers, and those interested in the subject.

W. H. GRANT.

General Notes.

AUSTRALASIAN GOLD.—On the 31st December last the gross output from Australasian goldfields amounted, according to the United States Consul at Melbourne, to 99,592,305 ounces, as follows:—Victoria, 61,034,884 ounces; New Zealand, 13,312,837; New South Wales, 11,710,510; Queensland, 11,172,073; Western Australia, 967,626; Tasmania, 886,822; and South Australia, 507,553 ounces. This enormous mass of gold represents the work of the miners from the discoveries in 1851 until the close of 1896. It will be noted that the total falls short of 100,000,000 ounces by 407,695 ounces. As this amount is very much less than the average yearly yield, it may be assumed that the shortage will be easily made up this year. The returns show that the yield of gold is increasing, for in 1894 the amount produced was 2,243,716 ounces; in 1895, 2,359,244; and in 1896, 2,375,948 ounces.

PRODUCTION OF BOOKS IN SPAIN.—During the last five years, 16,463 books have been copyrighted in Spain, of which 10,000 are credited to Madrid, and the rest to the other cities of Spain. The average number of books published in Spain yearly is 1,176, of which 790 are printed in Madrid, 239 in Barcelona, and the rest principally in Seville, Valencia, and Saragossa. The explanation of the paucity of literary productions in Spain is to be found, Señor Diaz Pérez recently asserted, in the fact that of the 17,500,000 inhabitants of Spain, only 6,000,000 can read and write. That there should be a large demand for the works of Spanish authors might be inferred from the fact that there are 65,000,000 Spanish speaking people in the world; but recent statistics prove that only 3 per cent. of the Spanish books imported to the 38,000,000 Spanish speaking inhabitants in the western hemisphere come from Spain, while the remaining 97 per cent. are imported from countries whose language is not Spanish.

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International Congress on Technical Education.

TUESDAY MORNING, 15TH JUNE.

Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., in the chair.

Professor Otto N. Witt's paper was read by Sir John Donnelly.

ON THE RELATIONS EXISTING BETWEEN THE TEACHING OF PURE CHEMISTRY AND APPLIED CHEMISTRY.

By Otto N. Witt, Ph.D.
Professor of Chemical Technology at the Royal Polytechnic School of Berlin.

It is a well-known and universally admitted fact that no branch of industrial enterprise has met, during the latter half of our century, with such signal and varied success as chemical industry. New manufactures, based on chemical principles, have been created and developed to colossal importance; branches of chemical science, considered too intricate and special even to be mentioned in the ordinary text-books of chemistry, have become the foundations of new manufactures; substances which in former times have been known as troublesome refuse have proved a more potent source of national welfare than even the richest gold-mines.

It is more than probable that we are as yet only in the beginning of this wonderful development, and that the industrial chemistry of the future will yield a harvest even more magnificent than it has done in the past. Much that has been sown has not yet reached maturity, and new seed is constantly being entrusted to the fertile soil. The investigation of the natural resources of foreign countries has shown that the conditions of industrial chemical work are by no means everywhere the same as in the civilised countries of Europe, and that in some cases they are more favourable. The liquid and gaseous fuels of the United States and of Russia are ample proof of this assertion. Great continents overflowing with wealth are yet awaiting their development; all that we know of them is that they harbour treasures of enormous magnitude, and that these treasures can only be raised by methods different from those which we have adopted for developing the resources of Europe. Yet the technical chemistry of Europe will for ever be the starting-point for the development of the technical chemistry of the world.

With this bright prospect before us it is only natural that we should be very anxious about the proper education to be given to those who are destined to develop and enjoy what to us is but a brilliant vision. Hence the great importance that has of late been attached to all discussions on the proper teaching of applied chemistry. If, in such discussion, the question has now and then been considered from a national point of view, the natural conditions of the country in question had to be taken into account. On the occasion of this International Congress, however, the noble struggle between peacefully competing countries can be of but secondary importance compared to the question equally important to all civilised countries, how we are to prepare our sons for their future work, how we are to protect them from the errors into which we have occasionally fallen ourselves, notwithstanding our success.

From the foregoing sketch of the prospects of industrial chemistry, it is apparent that no definite view can be formed of the exact shape which the chemical industry of the future will take. Even in its original home, in Central Europe, the chemical industry of to-day is totally different from what it might have been expected to become by the most experienced technologist fifteen or twenty years ago. The great secret of the success of applied chemistry lies in its versatility, which enables it to adopt ever new and varying means for a useful purpose. On the other hand this very versatility prevents us from forming a definite idea of the exact nature of the road which will lead us to success.

The natural consequence of this uncertainty is the conclusion that our most important task in the education of young industrial chemists is to make them men of many resources. A special training, which may be useful enough in less changeable branches of manufacture, is little short of disastrous in all branches of chemical industry.

There is no objection to a special education, say, for engineers. For, no matter how brilliant the success of the newly-invented machines of the future may prove to be, the methods of working the parts of which they will be composed will remain essentially the same, and will only undergo modifications making them more effective and generally applicable. The methods again of estimating and calculating such machines will for ever be based on general considerations of mathematics. If a young man has thoroughly mastered both the theory and the rational construction of a steam-engine, he will not find great difficulty in the construction of a motor for compressed air.

The same conditions do not obtain for chemical manufacture. In our sphere it is not the methods of execution which undergo changes so much as the principles on which the manufacture is based. The consequence is that a young man specially trained for some branch of chemical industry would find his knowledge of but little use a few years after leaving the school in which he received his training. In order to remain efficient in his work he would have to acquire knowledge which has been considered unnecessary by his teachers, and in so doing he would have to undergo the weary task of becoming a self-made man.

This difference of industrial mechanical and chemical work is greater than perhaps it may seem at first. It is more of a qualitative than of a quantitative nature. The mechanical arts, dealing with the physical properties of matter, are comparatively simple in their theoretical foundations, but of almost unlimited variety in their practical resources. Applied chemistry, on the contrary, is comparatively simple in its practical aspect, but extremely varied and complicated from a theoretical point of view. From this it results that the only possible way to success in applied chemistry is the acquisition of sound theoretical knowledge. It is a complete scientific education, which we must give to our young chemists in order to enable them to be successful in their industrial career.

Chemistry as a science is an organic whole, and its parts are inseparable. It is therefore a great mistake to think that the theoretical education of a young chemist may be limited to that part of chemistry which forms the basis of some given industry. Even the distinction, so often made, between inorganic and organic chemistry, cannot be upheld if we examine the subject logically and carefully. Organic chemistry is but the chemistry of carbon compounds, and there is no reason whatever for excluding one element from the theoretical education of a young chemist. The theoretical foundations of the chemistry of to-day are in a great measure derived from research in the domain of organic chemistry, and the information of a chemist who would strictly limit himself to inorganic chemistry would for ever remain incomplete and undigested.

No matter, therefore, what the ultimate destination of a chemist may be, his education should be strictly scientific and theoretical, and it should embrace general, inorganic and organic chemistry, without any preference for any or either of these separate subjects, but with constant reference to their various applications.

The success of the German chemical industry, so much commented upon of late, is in a great measure due to the fact that the men who founded it were the pupils of chemists, like Liebig, Wöhler, Hofman, and others, who knew no higher ambition than the thoroughly universal and scientific instruction of those who had the privilege of working in their laboratories.

From the foregoing remarks it will be evident that I am no adherent of special technical education in applied chemistry, if by that term we imple a one-sided preparation of young men for a single branch of chemical industry, no matter what that branch may be. Dyeing, calico-printing, and paper-making are perhaps the only chemical industries which may rightly claim the necessity of some special instruction in the methods of their manipulation. But there is no reason why this instruction, which is comparatively simple, should of necessity be separated from the theoretical training of a chemist. Of course the great centres of these industries will always demand and have their special schools for the education of young chemists for their factories. But if these schools are to be really useful, if they intend to produce men who shall be the originators of progress in their manufacturing districts, they will have to make provisions for as complete and efficient an instruction in theoretical chemistry as may be obtained anywhere in a university.

If thus pure chemical science is to be the foundation-stone of all chemical instruction, it becomes necessary to say a few words about the proper way of teaching chemistry as a science. Here I must say, that I do not agree with the method adopted now-a-days in many schools that I am acquainted with. There is a great tendency to accentuate the hypothetical chapters of the science at the expense of its practical and experimental side.

As is natural, a science of so progressive a character as chemistry cannot do without a good deal of hypothetical speculation. The theory of aromatic compounds, the considerations on the valency of the elements, the periodic law, even the atomistic theory itself are all nothing but hypotheses, though indispensable for the proper understanding of chemical reactions. So great has been their influence on the progress and development of chemistry, that slowly and gradually many chemists have got into the habit of considering them as the real essence and element of chemistry, whereas in reality they are nothing more nor less than general expressions of countless experimental observations. They are the great landmarks in that wonderful system which alone enables us to grasp and oversee the vast domain of chemical transformation. But they assume the nature of mere philosophical tricks, if we try to consider them apart from chemical facts in an abstract manner. That is what many chemists are now in a danger of doing.

Almost all our chemical text-books begin with the explanation of this hypothetical part of our science, and many lecturers do the same, whereas the proper way would be to make the beginner acquainted with facts and to derive from them the laws which govern them. The consequences of such a mistake are almost ineradicable. The young chemist, once accustomed to consider theory as independent of its experimental origin, does not see the necessity of connecting it with his experimental work in the laboratory. The consequence is, that the majority of the young chemists of the day, instead of being imbued with one living science, are possessed of two things, both of doubtful value: theoretical knowledge, acquired by memory and soon forgotten in practical life, and practical rule of thumb, incapable of helping them in serious research.

Yet the highest object of all chemical instruction is to show the way to chemical research. No matter what the ultimate career of the young chemist may be, whether he devote his energy to pure or to applied science, patient research will always be his only way to success. Whether his object be to create a new industry, starting from a new raw material, or whether his task be to improve old processes or to find the causes of troublesome difficulties—the way to success in all these different tasks is always the same, it consists in a logical application of the old, well-known and time-honoured methods of experimental research, either analytical or synthetical.

Our young chemists of the day are not sufficiently indoctrinated with the view of an experiment, as a question addressed to Nature. Being accustomed to consider theories independently of facts, and facts independently of theories, they are incapable of drawing conclusions from one experiment, and making them the basis of the next following one. Consequently they are incapable of research, for research is nothing else than a succession of experiments, each forming the direct consequence of the preceding one.

It will no doubt be considered remarkable, that I, a teacher of chemistry in Germany, the home of research laboratories, complain of an insufficient capacity for research in the majority of our young chemists. Yet that complaint is by no means unjust, and the cause of the difficulty complained of is perhaps still more remarkable than the necessity of the complaint. This cause is nothing more or less than the fact, that most young chemists devote themselves to research at too early a period of their studies.

To be successful in original research a chemist should be fully conversant with all the difficulties of chemical manipulation. This is but rarely the case with the young chemists of the present day. Their manipulative skill is quite undeveloped. They are sadly inexperienced in the art of building up an apparatus for a complicated chemical experiment, they have an unjustified dread of somewhat complex analysis, they are totally innocent of the indispensable auxiliary arts of glass-blowing, grinding, filing, &c., and, what is worst of all, they are insufficiently acquainted with the use of that instrument—which has created modern chemistry—the balance.

How are we to change all this? By a proper reorganisation of the early stages of chemical instruction.

I have already indicated that lectures on chemistry should not begin with the explanation of chemical theories, but with the demonstration of facts, which should be chosen in such a manner, that the theoretical conclusions may be deduced from them. In the same way instruction in the laboratory should begin with the observation of reactions, chosen in such a manner, that by degrees some of the simpler methods of manipulation are acquired by the pupil. As soon as he is acquainted with these he may begin to make preparations, starting with products of a simple composition, and transforming them into others by processes, the nature of which he is able to understand; but as soon as he begins this work he should also begin to use the balance. In every experiment he should use weighed quantities of raw material, and he should ascertain the weight of the intermediate, final and bye-products. The experiments should be chosen in such a manner, that more and more complicated apparatus is required for them, and great care should be taken in insisting that every experimental plant constructed should be faultless in all its details.

Only after having acquired considerable skill in chemical manipulation should the student begin to do analytical work. After a short practice in qualitative analysis he should begin with quantitative work. Being acquainted with the necessity of ascertaining the weight of all matter taken into work, he would now easily become familiar with the use of the analytical balance, which would not remain (as it unfortunately does very often at present) an object of fearful veneration, but become an indispensable and well understood tool. This quantitative analytical work should be supplemented by a number of thermo-chemical and physico-chemical experiments.

Whilst this experimental work is carried on, the student has become acquainted in his lectures with the subject of organic chemistry. Organic analysis may now be taken up in the laboratory. As soon as the young chemist shows some efficiency as an analyst of organic substances it is time to begin with organic preparations; but here again an exact record should be kept of the quantitative conditions of every experiment. The use of weights and measures should become second nature to every chemist, and nothing is more important in the practical instruction of a chemical beginner than to imbue him with the conviction, that merely qualitative work is imperfect by nature and only admissible as a preliminary preparation to the quantitative experiment, which, if properly carried out, is perfect and necessary as a supplement of the qualitative observation.

Another important point in chemical instruction is the constant reference to the practical applications of facts and theories. If the teacher would take constant care to explain what alterations of the plant and the conditions of an experiment are necessary for its execution on a manufacturing scale, why such alterations are necessary, then he would contribute more towards the formation and growth of industrial comprehension in his pupils, than can be done by any special technical instruction.

I have no hesitation in saying, that a young chemist, who has followed with all necessary industry and intelligence, a course of instruction such as I have sketched it, will be properly prepared for original research. This is equivalent to saying that he will be equally prepared to fill with advantage a position in a chemical factory in any branch whatever. His education will be complete and what he still lacks will be the experience and the rapidity of practical work, which can only be acquired by continued practice.

A few words remain to be said about the other subjects which, besides chemistry, should be taught to every young chemist. Of course, he should receive a proper instruction in physics, the elements of mechanical engineering, technical drawing, mineralogy, botany, &c. A certain knowledge of all the exact sciences is indispensable to every chemist, whether he intends to devote his work to industrial or to purely scientific research.

The essence of my investigation is, that I cannot admit any fundamental difference in the methods of research of pure and applied chemistry. Consequently I cannot admit the necessity of a difference of instruction for the two. A well organised instruction in pure chemical science would, in my opinion, be the best preparation for any young chemist for his future career. The method in use at present seems to be capable of improvement. Though much of what I have brought forward would not seem new to many of my colleagues, yet it cannot be said to be generally admitted, an it is certainly worthy of the most serious consideration.

We want no schools for producing specialists. Specialism comes as a matter of course in later life. But no matter how deep any chemist may involve himself in the intricacies of any given subject, he can still gather useful information for his own work from the contemplation of work accomplished in other branches of his science. If we want our schools to produce men fit to reap the great harvest before us, then let them produce chemists who enthusiastically embrace their science as a whole, and who are incapable both of separating practice from theory, and theory from practice.

At the conclusion of the reading of the paper, Major-General Sir JOHN DONNELLY, K.C.B., said that it was at his special instigation that Professor Witt prepared his paper, but he (Sir John) had no knowledge of what his views might be, but he did know that from his position and previous experience no one was better qualified than Dr. Witt to give a valuable opinion. It was, therefore, with great satisfaction that he had read his paper, as it so thoroughly endorsed the views which the Science and Art Department had endeavoured to inculcate, so far as it could, in the classes connected with it, that the only true foundation for technical education was a thorough instruction in general science, and also in its endeavours to impress upon schools the vast importance of practical work in any scientific education.

HEURISTIC INSTRUCTION IN PHYSICAL SCIENCE.

By H. E. Armstrong, Ph.D., LL.D., F.R.S.
Professor of Chemistry in the Central Technical College of the City and Guilds of London Institute.

However diverse, or even incompatible, may be the meanings which are read into the expression "Technical Education" by the various persons who nowadays constantly refer to it, the movement in this country is undoubtedly the outcome of fairly universal recognition of the fact that modern requirements are not met by the provisions made in our schools, colleges and universities.

Of late years, we have learnt much from the various attempts that have been made to improve the teaching, and the experience gained will be of the greatest value in enabling us to shape our future course. Yet it is clear that in introducing new subjects of instruction, and in seeking to establish a new tone of thought, we have rarely been sufficiently mindful of the principles underlying all true teaching; and much remains to be done if we are to develop a consistent and complete doctrine of education. The efforts made have too often been but sporadic and uncoordinated. Under the English system especially, education is far too much an affair of buildings: method and teachers, the primary factors in the problem, play as yet an altogether subordinate part. And it cannot well be otherwise, as it is very largely a case of the blind leading the halt, for we have yet to discover new and more suitable methods, and of necessity there are few who have the ability and experience requisite for successful work in such a field. But as those who control affairs are for the most part entirely without technical experience in education, it is all important to lay down for their guidance the principles on which success must depend: meetings like the present Conference offer an invaluable opportunity, and I therefore crave leave to briefly recite the history of a movement with which I have long been intimately connected, and which I venture to think is likely to contribute in no slight degree to our public welfare, by developing exactly the spirit that it is so necessary to create if we are to work with advantage under modern conditions.

On the occasion of the important International Conference on Technical Education held in London in 1884, in connection with the Health Exhibition, it was my privilege to read a paper on the teaching of natural science as a part of an ordinary school course, in which the method of teaching chemistry in science classes, schools and colleges was discussed.

Fortunately, I have since had the opportunity of gaining much further experience, and have been able, in consequence, to very greatly improve and develop the scheme of instruction I recommended. Meanwhile, I have had the very deep satisfaction of seeing the ideas advocated in 1884 put into practice by others and favourably reported on. In fact, the principles of the party I represent are gradually becoming fashionable—even the compliment is being paid us of "stealing our thunder," and books are being written to display what some are pleased to term the *new method*: but these are chiefly interesting at present as showing how difficult it is, even for those who would rate themselves our disciples, to fully grasp our meaning, and to divest themselves of the prejudices acquired in working under conventional conditions.

It is satisfactory, however, that not only have our pleadings influenced Government Departments, but it is even rumoured that so ultra-conservative a body as the University of London may, at no distant date, also to some extent adopt our principles and introduce changes which might, with the greatest benefit, have been made at any time during the past dozen years—changes which certainly would have been made years ago if it had been incumbent on an University in this great metropolis to seriously engage in the work of education, and to consider methods of teaching instead of paying exclusive attention to the soporific but lucrative business of examining.

To continue my historical account: in 1887, a highly representative committee was appointed by the British Association to inquire into and report upon the present methods of teaching chemistry. A preliminary report was presented by the committee in 1888, and in the two following years further reports were made which had the inestimable advantage of being constructive. The attitude adopted by this committee is expressed in the following quotations from their report presented in 1889:—

"The committee are convinced that the high educational value of instruction in physical science has never been exhibited to its full advantage in most of our educational institutions. Nevertheless there exists already a considerably body of experience which proves that there is no more effective and attractive method of training the logical faculties than that which is afforded by a properly arranged course of instruction in physical science; by no other means are the powers of accurately ascertaining facts, and of drawing correct inferences from them, so surely developed as they are by the study of this subject.

"It cannot be too strongly insisted that elementary physical science should be taught from the first as a branch of mental education, and not mainly as useful knowledge. It is a subject which, when taught with this object in view, is capable of developing mental qualities that are not aroused, and indeed are frequently deadened, by the exclusive study of languages, history, and mathematics. In order that the study of physical science may effect this mental education, it is necessary that it should be employed to illustrate the scientific method in investigating nature, by means of observation, experimenting, and measuring with the aid of hypothesis; the learners should be put in the attitude of discoverers, and should themselves be made to perform many of the experiments. The lessons ought to have reference to subjects which can be readily understood by children, and illustrations should be selected from objects and operations that are familiar to them in every-day life. Chemistry is particularly well-adapted for affording this kind of instruction, and the committee are of opinion that a course which is mainly chemical will be most useful in developing logical habits of thought.

"Chemical inquiry involves, however, the use of various physical processes, and these are themselves of great value from the point of view from which the instruction is being given. It is also of great importance that the learners should become acquainted with the characteristic instrument of physical science, viz., measurement, and therefore quantitative processes should be largely made use of.

"They do not desire to bring forward physical science as a substitute for any of the subjects of study, but they ask that like these subjects it should be looked upon everywhere as a necessary part of education, and that it should receive a due share of the time devoted to school work."

A series of suggestions for a course of elementary instruction in physical science, drawn up by me, were embodied in the Report issued by the British Association Committee in 1889, and further suggestions of mine were printed in the Report issued in the following year. These British Association Reports have, in consequence, I believe, served as text-books for several years past, and have thus been of considerable service to teachers.

In my paper read at the Health Exhibition in 1884, when drawing attention to the imperfections in our methods of teaching as the chief explanation of the backward position of science, I pointed out that the earnest cooperation of a number of specialists was needed in order to develop a rational system of instruction suitable for schools. Nothing is more striking than the apathy of teachers in these matters, and their slowness to avail themselves of the infinite opportunities at hand to engage in *educational research*. The point is worth making, as this apathy probably arises from the fact that teachers generally are themselves without training in the methods of research—indeed, in common with the general public, have far too often no clear conception of the meaning of the word. Consequently, if we are to improve the race of teachers, one of the first things to be done—whatever may be the subject to which they are to devote themselves—is to so train them that they may be in a position to develop satisfactory methods of teaching. It stands to reason that we neither are attained, nor ever can attain, to finality in such matters, and that as we cannot yet properly teach those who would be teachers how to teach—for we do not yet know ourselves—we must fit them to be always learners themselves. A purely didactic system, such as we now follow, which gives us no such help, stands self-condemned.

The keynote of the recommendations of the British Association Committee is in the sentence—"The learners should be put in the attitude of discoverers." The method we advocate is well termed the "Heuristic" method (εὑρίσκω, to find out); it is the absolute antithesis of the didactic method.

Although the British Association Committee's report contained suggestions for a course of elementary instruction in physical science, no actual syllabus of a course was in the hands of the public until a couple of years ago, when a committee of the Incorporated Association of Head Masters took the matter in hand and issued a syllabus together with brief instructions as to the character of work to be done by students; this was practically a reproduction of the British Association Committee's scheme. The Incorporated Association of Head Masters not only adopted the syllabus drawn up by their committee, but took the further important step of memorialising both the Cambridge and Oxford Local Examinations Syndicates, requesting them to introduce the course into their scheme of examinations. Their recommendation was in due course adopted.

But even at an earlier period, now more than five years ago, heuristic instruction on the lines recommended by the British Association Committee was introduced into one of the four districts into which the London School Board is divided, viz., into the East London and Tower Hamlets division, by Mr. Hugh Gordon, M.A., to whose energy, tact and skill we are indebted for the proof that work such as the British Association Committee contemplated can be carried out with the greatest readiness even in public elementary schools, and with the most favourable results. Since Mr. Gordon's appointment as an inspector under the Science and Art Department, the work has been continued by Mr. W. M. Heller, who has been equally successful. Both Mr. Gordon and Mr. Heller have done the greatest service by gradually training the existing staff of teachers in their district to carry out the work—in fact, they have experimentally ascertained and demonstrated how heuristic training in physical science can be actually carried out in schools: a particularly important achievement in view of the character of the material they had to deal with.* The syllabus under which they have worked was introduced first into the evening schools' continuation code, and subsequently into the day schools' code for boys; only this year a similar scheme appears in the code for girls. Unfortunately the code still permits the teaching of so-called specific subjects —such as agriculture, electricity, magnetism— and in a manner, moreover, which deprives the teaching of all educational value. A memorial was addressed to the Vice-President of the Committee of Council on Education early in the year by the Joint Scholarships' Board—a highly representative body that is probably destined to play an important part in the future organisation of our educational forces—but it is almost needless to say that the recommendation was passed over which this Board made that direct encouragement should be given to a course which practice proves to be rational, successful and scientific, rather than to the purely didactic teaching from which it is impossible to escape when specific subjects are taken. The day is probably far distant when educational questions of moment will be dealt with officially on their merits in this country—private effort and the pressure of public opinion at meetings like this can alone be relied on to effect the necessary changes.

I have dwelt on the history of the attempt to introduce the heuristic method into schools because I am firmly convinced that there is no more important subject for consideration on an occasion like the present. It should need no argument to prove that it is necessary to train boys and girls to use their wits and help themselves, but it is surprising how very few are prepared to admit that any departure from established methods, such as we advocate, should be made. The fact is—and it is important to state it in all its nakedness and with emphasis—we are using language which is strange even to nearly all who are directly engaged in the work of education. Our position, therefore, is a difficult one, and we can but ask that we be given proper opportunity of proving in practice that our method is sound and when properly applied gives results far superior to any attained under existing conditions. It has the advantage of being a method which is applicable to all subjects, and we contend that it should be applied to all subjects. It is only because chemistry offers opportunities which probably no other science offers to the same extent, that it is advocated that this subject be largely made use of in schools: but the chemistry we desire to have taught is neither the chemistry of the text-books nor that of the technical chemist; and it does not merely involve making a few gases, &c., and indulgence in a certain amount of elementary test-tubing. What we aim at is the reintroduction of the style of work practised by men such as Black, Scheele and Lavoisier. When thus carried out, chemical education cannot be otherwise than a most efficient preparation, especially for those who desire to follow an industrial career.

All who are engaged in the work of technical education proper are agreed that at present it is almost impossible to obtain satisfactory results owing to the fact that the students have not been properly prepared at school. If we can but succeed in disciplining the minds of students while at school, they will then be able to devote themselves to technical studies with far greater advantage than has heretofore been the case.

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* Most important testimony to the value of their work is given in the letter at the end of this paper, which I am permitted to quote, from the distinguished physicist, Professor Fitzgerald, F.R.S.

But there are many directions in which changes must be made. A fundamental fallacy of modern education, and probably of technical education especially, arises from the desire to cover too wide a field. The inspectors are hampering the development of heuristic teaching even at the present time by complaining that progress is far too slow in the direction of acquiring knowledge of facts: they will not sufficiently recognise that habits are of primary importance. The execrable system of examinations we have allowed to grow up has engendered an altogether false conception of what a child is and can do and should do: we are fast coming to regard the pupil as a kind of animated set of pigeon holes, into which every sort of fact can be crammed and taken out again when required; experience shows, however, that the child behaves much as the pigeon holes would, taking in and giving out information more or less readily, but without digesting it—without ever learning to properly apply it.

Each year the demands made upon the student increase with the growth of knowledge. The period of study is all but entirely absorbed in acquiring knowledge of what others have done, together with a certain amount of mechanical dexterity. But worst of all, an entirely false mental attitude is engendered by the ever present fear that the examiner will ruthlessly demand a balance of accounts.

It is very strange that we should be engaged in depriving our educational system of almost every element of elasticity by instituting a modern inquisition outwardly less cruel than that by which our forefathers were at one time oppressed, but probably far more insidiously fatal and widespread in its effects; and strangest of all that we should allow such an inquisition to become established in private hands, and free from State control, as a highly lucrative business.

As it is necessary to state in advance what will be the requirements of the examiner, examinations cannot fail to be behind the times; but their worst effect is the tendency they have to stereotype teaching, and especially to lead the student to pay attention only to those matters which will meet with official recognition. It is in this respect that the Germans are so vastly ahead of us in their universities; they alone put proper faith in their teachers, and success has entirely justified their action.

It is true that in not a few cases at present, those who are examining are among the most competent teachers, and that the examinations serve the useful purpose of guiding teachers who are incapable of devising rational and satisfactory courses of instruction. But this is only a temporary condition of affairs, and it behoves us to see that in creating a system useful under present conditions we do not seriously prejudice our chances in the future when more healthy conditions come to prevail.

Steps should certainly be taken to stamp out the disease of certificate hunting and prize taking which is gradually spreading over all classes—a higher moral purpose should dominate both teachers and students. In London especially is this necessary. Nothing is more surprising—and nothing more clearly illustrates how little originality is embarked in our educational enterprises—than the fact that the various London Polytechnics, each one of which should be a centre of independent and uncontrolled effort, are very largely engaged in teaching for the Science and Art Department Examinations. Such examinations, no doubt, have in their day served a useful purpose, but for the most part they have long since ceased to be otherwise than a hindrance to educational progress—a fact which is gradually but all to slowly being recognised, and which it is sought to remedy by the appointment of inspectors in place of examiners. But the greatest care will have to be taken in making this new departure, for unless the inspectors have been heuristically trained, they may become even a more serious danger than the examiners, as it will be more difficult to criticise their actions. Some machinery must be organised whereby those in whom the control of education is vested are perpetually brought into contact with those who are engaged in the work of education, and especially with those who are actively engaged in improving the methods of teaching, *i.e.*, in educational research.

It is the entire absence from our English system of any regulated and complete course of training as the necessary preparation for industrial and tutorial occupations that has given such fictitious value to certificates, and therefore to examinations. Let us hope that the time is not far distant when evidence of training—and before all things, of heuristic training—will be regarded as of chiefest value.

But whatever be done, it is surely desirable that we should be scientific in evolving a programme for the future; that we should consider the nature of the problem in hand, and while making the fullest use of accumulated experiences should free ourselves, as far as possible, from the influence of tradition. Our present system, be it remembered, has been gradually evolved to satisfy conditions altogether different from these under which we now work, and it stands to reason that we should be prepared to dispense even with much that has proved to be of value in the past.

We cannot go wrong, if we set to work from the proper point of view. A vast change has taken place within recent years owing to the introduction of practical studies—in fact, quite a revolution has been effected in this direction. But there is undoubtedly a tendency for such work to be done in too mechanical a style. If we can but graft upon the modern tendency to be practical a proper utilisation of heuristic methods, we cannot fail to succeed in training up a race of competent workers of all grades.

"Trinity College, Dublin,
"6th May, 1897.

"Dear Mr. Heller,

"I have had a good opportunity of comparing the methods of science instruction in several different places in England during my recent visit to England in connection with the 'Commission on Manual and Practical Instruction in Primary Schools in Ireland.' I took a very keen interest in what I saw, and especially in your work in London. I have been most favourably impressed with the methods you are employing, and from what I saw of its work in the schools am convinced that it is working out in practice what it is designed to do, and is capable of being introduced into any school by intelligent and well-trained teachers.

"Your methods are intelligible methods, and can consequently be made the basis of an intelligible system which can control all the methods of the teacher, and give him an intelligible clue for developing the methods to suit the varying circumstances of his school and locality. In that respect it seems to me to have an overwhelming advantage over, what I may describe as, the hand-to-mouth methods of others.

"With the deliberate end in view of teaching children by a connected system of simply-graduated experiments to learn how to read nature, make her answer their questions, and thus provide themselves with the means of learning her laws, and how to control her for their advantage, you have a fundamental principle of true scientific education that puts the child in possession of the means of further advance, and is quite as essential to its well-being in life as to give it the ability to read.

"Most other methods of scientific education are analogous to the aboriginal methods of literary education by teaching children to learn Homer by heart. So far it was of use, but when literature grew it was much more important to teach a child to read than to teach it almost anything by heart. Similiarly, the really important thing in scientific education is to give a child the ability to read nature and to understand her. The time has gone by for learning off all that is known about her.

"The methods of experimental enquiry are themselves so very different from those of literary enquiry that they must be specially taught, and the methods of teaching them differ in so many important respects from the methods of teaching things that can be read about, that it is essential that the teachers of the methods of experimental enquiry (a much better general term than Physics, Chemistry, &c.) should have a special training.

"This is all the more necessary at present when we are trying to change the system of scientific instruction from that into instruction in the methods of experimental enquiry, because so many of the teachers and of would-be teachers have already had wrong ideas implanted in them by being brought up in a very imperfect system.

"At the same time that a practical training of teachers to these good ideas is so essential, the fact that an intelligible system and an intelligible end underlies your methods should ensure that your system and ideals could be grasped and worked out by any properly trained teacher.

"I have been so fully impressed with the advantages and workability of your system that I shall use my endeavours to have this rational system introduced wherever practicable in our Irish schools, and feel no doubt that wherever any science education is practicable, your system, modified as to its details to suit localities, &c., but unmodified as to its ideals and essential methods, will be found by far the most practicable of any, and by far the most valuable as regards its results.

"Yours very sincerely,
"Geo. Fras. Fitzgerald."

THE TEACHING OF CHEMISTRY IN EVENING CONTINUATION SCHOOLS.

By J. H. Gladstone, Ph.D., D.Sc., F.R.S.

The teaching of chemistry is provided for in several ways by the Government Code for Evening Continuation Schools. It is encouraged by grants, and leads up naturally to the more definite technical instruction which is given in colleges and polytechnics, and under the auspices of County Councils.

Chemistry appears in the Code as one of the science subjects of the Schedule. It may be taught as a continuation of lessons given in the elementary schools under the same name, and it may be a preparation for classes under the Science and Art Department. It also appears under the heading of "Elementary

Physics and Chemistry," which is defined as "a systematic course of practical instruction for the scholars themselves. The complete set of experiments should be carried out by the class (*i.e.* the scholars) as a whole." This includes measurement in all its branches, with air, water, and chalk very fully investigated. It does not lead so directly to the Science and Art Department's examination, but it would be a natural sequence to the instruction given with much success in many of the London Board Schools, and it is of special educational value. Chemistry occurs also under the heading of "The Science of Common Things," which is defined as "a brief survey of physical properties of bodies serving to determine their uses and relative value," and includes "the most essential facts and principles of inorganic and organic chemistry." The same science again forms part of the subject "Domestic Science," which appears in the Code this year for the first time. The intention is "that the instruction in this subject should be based on experiments performed as far as possible by the children themselves. The applications to the home should be the results of the discoveries made in the course of the experiments, which should be undertaken in a spirit of inquiry or re search." Thus, in the extended syllabus, each point is illustrated and enforced by some practical work, and it may be looked upon as the chemistry of the home.

These subjects have not been much taken up in the evening continuation schools of the metropolis. In the report of the London School Board for 1895-96, it appears that out of the great aggregate of 69,900 completed twelve hours attendances on which the Education Department have paid grants, "Chemistry" accounts for only 404, "Physics and Chemistry" for 152, and "The Science of Common Things" for 468. The total of these three being 1,024, only one-sixty-eighth part of the whole. In the classes under the Science and Art Department it appears that, out of 4,376 scholars, only 255 took chemistry, one-seventeenth of the whole.

In Manchester, on the other hand, documents furnished me by Mr. C. H. Wyatt, Clerk to the School Board, show that they have a very elaborate system of Evening Continuation Schools, with 12,451 scholars, in which elementary science is one of the subjects taught. These, together with the Higher Grade Day Schools, with 6,619 scholars, lead up to six Science and Art Evening Schools in which chemistry, both inorganic and organic, is taught by means of lectures illustrated and explained by experiments and specimens. Laboratories for practical chemistry have been fitted up at each of these schools, with one exception. These six contain at present 2,738 students. The Evening Continuation Schools also lead up to the Evening Institute for Women and Girls, with 970 students, in which there seems to be a good deal of applied chemistry in the form of cookery, hygiene, &c.; and to the Commercial Evening Schools, with 4,261 students, in which elementary science may be continued. The system is rendered complete by the Central Science and Art Evening School, which practically teaches the whole of the subjects comprehended in the directory of the Science and Art Department. The control of this school has lately been handed over to the Technical Instruction Committee of the City Council.

Very important is the method of teaching science in these evening classes. It is possible to give instruction in chemistry merely by means of books or oral lessons; this would make it a mere unintelligent exercise of the memory, and would waste the scholar's time. Chemical and physical science is often taught by means of demonstrations, the teacher showing pictures or specimens of the subjects mentioned, or performing experiments before the class with good apparatus and proper explanations. This is good, for it gives a certain amount of information and arouses curiosity. But there is another method which appears to me far better: that of the student himself handling the objects and making the experiments under the supervision and direction of the teacher, and making notes of what he has done or seen. This method will lead to few results that can be tested by an ordinary examination; but it will train the student's power of observation, educate his senses, give him facility in arriving at accurate knowledge, and form in him habits of mind which will be invaluable to him in his future career. The lessons should be simple, for an untutored mind will generally be very slow in grasping ideas; the objects presented should be few in number, and well chosen; and the experiments should be made as far as possible by means of things with which he is familiar. Thus the phenomena of solution can be better shown by using sugar or salt, than any of the strange things in a druggist's shop. Novel or complicated apparatus is to be avoided, as it puzzles the brain of the beginner, and draws off the attention from the facts that are to be studied; besides which it costs money. The greatest discoverers in chemistry, such as

Cavendish and Dalton, usually worked with the simplest of tools and apparatus. The Royal Institution possesses a collection of corks, bits of sealing wax, twisted wires, and such common things, with which Faraday investigated the secrets of nature. Galileo, watching the swing of the lamp hanging from the roof of the Cathedral at Pisa, measured the period by counting the beats of his own pulse, and in this way he made the great discovery of the isochronism of the pendulum. The pupil should be directed to observe carefully which is much more easy when the objects are handled and the experiments are made by himself, and the practice of making written notes will greatly quicken his perception. Accuracy of weighing and measurement should be required, as far as the means of observation will admit, yet he should not be allowed to suppose that absolute accuracy is obtainable, even when he is using elaborate apparatus, but rather should be led to form an estimate of the probable limit of error in his work. Whether the young student has an intelligent appreciation of what has taken place in his experiment will be discovered probably by the way in which he describes it; and if the teacher finds that it is erroneous, he will suggest such a modification of the experiment as will lead the learner to perceive for himself the inadequacy of his former idea, and to substitute some more correct description or explanation.

Though the first and main object of the teaching of chemistry should be an educational one, there is no reason why practical applications should be ignored. They will generally give additional interest to an experiment, and will serve to fix it on the memory. There is, moreover, a double advantage if the scientific lessons of the school can be put into practice in the workshop, the home, the kitchen, and the laundry.

Of course, many of the boys and girls in these evening classes will be engaged in future life in industrial pursuits where the knowledge of chemistry will be of direct service. When the school is situated in the neighbourhood of factories, it would be allowable and even desirable that the illustrations should be chosen with some reference to the prevailing industry. The lessons of the Continuation School will then prepare the way for the technical classes properly so called. Yet in the midst of practical applications it should never be forgotten that the main purpose of the scientific training here described is to develop the perceptive and reasoning faculties, to increase the pupil's interest in nature, and so to fit him better for whatever duties he may afterwards be called upon to fulfil.*

The CHAIRMAN said the discussion on the foregoing papers would be taken, and he would ask Sir Henry Roscoe to commence it.

Sir HENRY ROSCOE, D.C.L., F.R.S., said it could not be otherwise than gratifying to an old chemist—for he might call himself one, having taught chemistry for thirty years—that the first business of that International Congress should concern itself with the teaching of chemistry. He thought it was rightly so, for it was a subject, amongst all others, which lent itself, as Professor Armstrong had so clearly shown, to the application of what they might call primary scientific education. Looking back over a considerable length of time, he thought that all those who could remember what the condition of science teaching in schools was twenty-five or thirty years ago, would acknowledge that the progress which had been made was really marvellous. Then, the practical teaching of chemistry, or of any other branch of science, was unknown in the schools, but now, wherever a school of any considerable magnitude existed, they would find a well-fitted chemical laboratory. Much, however, remained to be done, but he thought all interested in this new education—or this new development of education—would congratulate themselves on the papers which they had just heard read, because they had been prepared by men of ripe experience, who were anxious that the old system should give place to the new. Dr. Armstrong had put forward his views so clearly and so forcibly that he thought they would commend themselves generally to those interested in the subject. Dr. Gladstone had done so much for the encouragement of education, especially scientific education, in the London County Council, where he had served for so many years, and on the Committee of the British Association, that his remarks would be received with great consideration. It must be remembered that in putting forward these views, they were really breaking new ground, and, from what had been said, we might fairly conclude that the position which primary education, from the scientific point of view, was taking in England was of a most satisfactory character. What we in England suffered from—and it was well that it should be known—was that our manufacturers did not at present see as they ought to see, the importance of the highest scientific training as applied to their industries. The other day he visited a large colour works near Frankfort, where over a hundred scientific chemists, highly trained, having devoted years to the prosecution of original research, were employed for the purpose of obtaining new results. We had nothing like it in England.

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* For a fuller treatment of some of the above points, see the admirable Presidential Address by Professor James Stuart, M.P., to the Norwich Conference of the Teachers' Guild' "Journal of Education," May, 1897.

The salaries paid to them were high. One gentleman had a thousand a year—a man of great distinction—and he did work there for years without obtaining any result of commercial value to his employers. After a while, however, he made a discovery which not only repaid them ten times over, but placed them in possession of a new branch of manufacture. That showed what could be done by the application of science to industry, and we should lay to heart the lesson which it taught. If only our manufacturers would appreciate the value of such work, we could turn out scientific men as well as any other country in the world. The point he wished to emphasise was that the manufacturers of England had not yet attained to that appreciation of the value of science which those in Germany manifested, because they gave but slight encouragement to scientific research. At the same time, they must remember that England had been the home of very many of the great discoveries in industrial chemistry in the past, and that it would be so in the future, he, for his part, firmly believed.

TUESDAY AFTERNOON, 15TH JUNE.

Sir OWEN TUDOR BURNE, G.C.I.E., K.C.S.I., in the chair.

REMARKS ON THE TEACHING OF CHEMISTRY.

By GEORGE LUNGE, PH.D.,

Professor of Technological Chemistry in the Federal Polytechnic School, Zürich; Past President of the German Society of Chemical Industry.

Having been asked by those in charge of the preparations for the International Congress on Technical Education, to be held in London during the month of June, to contribute a paper on the teaching of chemistry, I beg to make the following remarks on this subject.

I have on various occasions given utterance to my views on the most suitable course of education for technical chemists; also in an address delivered before the international congress of chemists, held in Chicago in 1893. There is all the less reason for repeating in detail what I formerly said on that subject, as I agree in the main with the numerous English chemists who have recently given to the public their ideas thereon. More particularly I agree with the views pronounced by Professor H. E. Armstrong in his pithy letters to *Nature*, written only a few months ago. In a few words: In order to raise English chemical industry to the foremost rank which is deputed to it at present in several important branches, it is necessary that the technical management of chemical factories should not be left in the hands of "rule-of-thumb" men, but should be entrusted to real chemists. These men should have a much fuller education than the majority of chemists seem to obtain at present in Great Britain, which means that they must spend more time and money on their training than they generally do. Before entering on their proper professional study at college, they should receive a more suitable general education, in which the "classics" need not be entirely left out, but must take a secondary place in comparison with modern languages, mathematics, drawing, and the elements of science. At college the student should receive a thorough training in scientific chemistry, taking this in its widest meaning, not merely as a "testing" business. Next to this, but not to the same extent, he should be taught physics, mineralogy, technology, mechanics, and the elements of engineering. Everything else is more ornamental than useful; but I am the very last to say that the student should confine himself only to the latter.

Nobody in these times of ours is likely to turn out a first-class chemist, worthy of being later on put in charge of a large factory, who has not tried his hand in original research. This has been pointed out with such cogency and emphasis by many authoritative voices in England (in Germany it has long been held as an article of faith) that I may abstain from dilating on that topic.

There is not quite so much agreement on the point whether technical chemists should be taught at college technology and the elements of engineering. Most people would take this as a matter of course; but there are influential voices to the contrary. We meet with such in the Report on the Teaching of Chemistry, made to the Technical Education Board of the London County Council in November, 1896. One gentleman declares the teaching of technological chemistry of no value whatever for chemical industries or for the pupils. Another declares that, although he had no preliminary technical training, and had been through theoretical courses only, he found himself able to cope with anything that cropped up when he entered manufacturing practice. Both gentlemen are eminently practical men for whom I, like all the world, entertain the greatest respect, but in the present case I cannot follow them, and I believe that their experience is too one-sided. I, for my part, trust that I shall not be judged arrogant for assuming my natural capability of being up to the average, but my experience has been as follows.

Having gone through a complete course of scientific chemistry and allied subjects (I rejoice to have had Bunsen and Kirchhoff as teachers), and having afterwards entered upon a technical career, I did *not* find myself "able to cope with anything that cropped up in practice," but I had to spend immense trouble and time, and to pay serious "Lehrgeld" for acquiring those elements of mechanical and technological knowledge which students now obtain as a matter of course in a good technical college. And this experience of my own agrees with so much else which I have observed in later life that I feel bound to retain my view of this subject as before stated. Nor do I stand alone in that. Not to speak of the practice of all the continental Polytechnics, which, after all, have some results to point to, great efforts have recently been made to introduce those technological subjects even at the German Universities, as it is felt that in that respect they are suffering under a drawback in comparison with the Polytechnics. A very forcible speech was delivered on April 28th of this year, in the Prussian House of Commons, by Dr. Böttinger, the head of one of the largest chemical manufactories in the world, with a staff of more than a hundred chemists (the Farbenfabriken at Elberfeld). Dr. Böttinger strongly demanded the establishment of more professorships of technological chemistry, also at the old Universities, in order to maintain the prominent position of Germany in the chemical industry, and the Government made a very encouraging reply to this.

It is quite intelligible why some large chemical manufacturers do not care very much about a preliminary study of technological subjects on the part of their chemists. At their colossal works they need specialists for each branch, and they cannot do without a staff of fully trained engineers, so that their chemists are not called upon to do any but strictly chemical work. Some owners of works may not even like their chemists to get too much insight into the practical and mechanical part of the manufacturing operations, for reasons which need not be dwelt upon here. But that cannot be our standpoint, as teachers, nor, do I venture to say, is it in the interest of the nation as a whole that a trade should be monopolised in a few hands, as it is the object of "keeping everybody to his last." On the contrary, we aim at educating our pupils in such manner that they can turn their energies into practical channels at any opportunity which may offer itself; for this purpose they must be able to cope with mechanical and technical problems at the outset, and they must be taught to *think technically*, not merely as test-tube men. Of this I may be allowed to give an illustration from a huge industry which is after all quite as much a branch of applied chemistry as, say, alkali making, viz., the manufacture of iron and steel. Does anybody maintain that the enormous strides made in this industry in our own generation would have been possible if the ironmasters and their assistants had been brought up on a diet of pure chemistry and physics, leaving all the practical part and the engineering to be either performed by non-chemical engineers, or picked up at hap-hazard later on by themselves, instead of their going through a thorough training in the technology of metallurgy at mining schools or the like? This *reductio ad absurdum* is perhaps not quite so apparent and absolute in other branches of the industries built upon a chemical basis, but in my humble opinion it applies there as well. I cannot consider it as an accidental coincidence that Germany, which had been one of the leaders in theoretical chemistry for a long time past, without developing a chemical industry commensurate with it, should have attained to such prominence in the same industry precisely in the period when the establishment of Technical High Schools had provided her with a number of chemists, trained in something else than pure science. It is really unnecessary for me to point out that such a training in *pure* science, and that of a most thorough kind, is the indispensable forerunner of the teaching of practical subjects, but, although speaking *pro domo*, I cannot help saying that *technological* chemistry has also amply proved its right of existence, and its great importance for the progress of chemical industry.

I have hitherto had only those in mind who aspire to filling the higher positions in chemical works, and ultimately hope to become themselves managers or owners of factories. Of course, only a few can ever reach that goal, and the great majority must content themselves with obtaining intermediate positions, but if they have honestly worked during their college time, they may trust not to be left always in the condition of "testing-slaves," but to be promoted to manage some part or other of the real manufacture. According to the way they perform that work, they will have a chance of getting on higher and higher. Such promotion is, on the Continent, now confined to trained chemists, and I believe it is also more common than formerly in England to make chemists managers of chemical works. So long as this is not a recognised principle, it is in vain to hope for retaining a foremost rank in chemical industry. It is another question whether it is necessary or useful for that purpose, as is sometimes claimed, that the foremen, or even the common workmen, should possess a certain knowledge of chemistry and technology, such as may be imparted at Board schools or at night classes for adults. I am afraid that such knowledge is quite useless to ordinary workmen, who have simply to do as they are told, and who may do more harm than good by trying to apply a superficial idea of the nature of the operations which they have to perform, without possibly having a real insight into them. I do not even think that, apart from isolated exceptions, such knowledge is of much good to the foremen, whose duty it is to carry out instructions and to see that the men do their work as prescribed by the staff, but who are not to meddle with the chemical process itself. Both classes of men may have valuable suggestions to make concerning apparatus and other outwardly visible points, but even if they have learned as much chemistry as they have had a chance to do in the ordinary way, it is most unlikely that they will be able to find out any improvements in the *chemistry* of the process. At all events, in Germany, even in those factories where the work is carried on with the greatest chemical refinement, the foremen and ordinary workmen are neither required nor even desired to know anything of chemistry. Formerly, it happened sometimes that one of the men, after getting such a smattering of chemistry as he was able to obtain by evening schools and the like, was driven on by an irresistibe impulse to rise from the ranks, to supplement his deficiencies by hard work, and to become a successful chemical inventor. But such a contingency has become more and more scarce with the widening of the area of science and the increasing difficulty of mastering it, and it really seems a great waste of time and means to give some superficial chemical teaching to tens of thousands of workmen on the remote chance that one of them may gain some real benefit from it, while at the same time many hundreds of educated men are receiving a really efficient training in the same direction, many of whom cannot find properly remunerated places owing to a great extent to the cheap labour of "bottle-washers."

Another outspoken word and I have done. Bodily exercise is an excellent thing; we all know *mens sana*, &c., and *sport* is a first-class inducement to bodily exercise. But even a good thing, pursued to excess, turns into its opposite. No sane person denies this in theory; everybody agrees that sport is not the only object of human life, and should be carried on in moderation. The question is only as to the point where to leave off. I have already heard many voices of Englishmen complaining that sport plays much too great a part in English education, and in English life generally, and that England cannot expect to keep up with other nations in science, arts, manufactures, and commerce, if not merely most young persons, but their parents and sometimes even their own teachers, continue to consider "book-learning" (including laboratory work!) as subordinate to proficiency in one or more kinds of bodily exercise. Nobody denies that all work and no play makes Jack a dull boy; but surely all play and no work makes him far duller, and even too moderate a dose of work with his play will not do for him in the long run. It is not for me to say how far those voices are in the right, and where the line should be drawn between mental and bodily education; that must be done by Englishmen for themselves, and they must abide by the consequences.

Professor SILVANUS P. THOMPSON, F.R.S., said he could not speak either as a chemist or as a teacher of chemistry; but, as Director of the Finsbury Technical College—which had been founded by the City Guilds, and which had been at work teaching not only chemistry but other subjects for more than 15 years—he thought he had had opportunities, at any rate of forming some sort of judgment of the nature which such teaching should have, and, he might add, that in speaking upon this point he also spoke for Professor Meldola, the professor of chemistry at their college, who, before holding that position, had a large experience in the manufacture of aniline dyes, and so forth. He took it that there were four purposes for which chemistry was taught in the various schools or institutions, which came within the four corners of the papers which had been read. In the first place, it might be taught in the schools as a portion of the general scientific training—as a portion of modern education. Secondly, it might be taught as a preliminary scientific training, not for the chemical industry, but for such professions as chemistry and pharmacy. The teaching of chemistry for these professions, naturally, might be conducted on somewhat different lines from the teaching of chemistry in the first category, or as distinct, on the other hand, from the teaching of chemistry for the purpose of the true chemical industries. Then, thirdly, there was the teaching of the chemist who was to take his place amongst the chemical industries—and he took it that the papers of Professors Witt and Lunge had been devoted exclusively to that aspect of the matter, and that they did not take into their purview the two preceding purposes he had mentioned. He also thought that Dr. Gladstone had dealt almost exclusively with the teaching of chemistry for the first of the purposes, and Professor Armstrong had devoted his remarks mainly to the first two. Fourthly, he maintained that there was scope in our institutions for the teaching of somewhat more specialised chemistry, because chemistry was wanted not only for the direct chemical manufactures, but those of less direct connection, such as tanning, where chemistry was the basis of it, and yet the chemistry wanted by the tanner was not of the same kind as that given in the training of the chemist who was a manufacturer of dye stuffs, or connected with bleaching, or any of the great chemical industries. He wished to confine his remarks to the two last and higher branch of training. He thought they all agreed with Professors Lunge and Armstrong, that a training in research was absolutely necessary to all those who went into chemical industries, but they ought also to agree with Professor Witt, that it was not wise that research should be taken by students too soon, before they had been taken through what might be called a good "all round" course in chemistry. In Germany it was quite a common thing for the students to spend not one or two, but five or six, or even seven years in the laboratories of the polytechnics, and consequently that which might be all right for students who had seven years to devote, might be entirely wrong for those who only had three years in the corresponding English institutions, and it would be well if it had been more clearly stated by Professor Witt, in warning them against too early research, at what precise period during the possible seven years he regarded as an "early period." One opinion was common to the papers, both of Dr. Witt and Professor Lunge, for they both insisted that he who was to be trained to go into the chemical laboratories as a trained chemist, should be trained not only in chemistry, but also in physics, mechanics, and engineering. In their own institution at Finsbury they had some difficulty in persuading the students to take any more interest in these allied subjects than was barely necessary to fulfil the curriculum. This was greatly to be regretted, as many of the chemical operations in manufacture were almost as much matters of engineering as of chemistry. Referring specially to such industries as tanning, glass-making, and dyeing, it seemed to him, in spite of what the authors of some of the papers had said, that there was room for institutions in which technical chemistry in its more restricted sense, as applied to one or more of these industries, might very profitably be taught. He believed that the Tanners' School at Bermondsey, sustained by the Leather-sellers' Company, was doing an exceedingly useful work for the tanners' trade in London, and in Bradford, Huddersfield, and Leeds, an admirable work was also being done by the teaching of technological chemistry in connection with the production of dye-stuffs, and in the application of chemistry to the textile industries He thought it would be a mistake that it should go forth from this Conference that higher training in chemistry should only be of one kind. He believed there was room for the teaching of true technological chemistry of the kind he had described, and that it would be best carried on not in those comprehensive institutions somewhat incongruously described as "schools of university rank," but rather in those which might be described as mono-technic institutions.

Mr. Alderman THOMAS SNAPE, speaking as one having had something to do with technical instruction in Lancashire, advised that they should insist upon making chemistry an indispensable subject in all technical teaching, and, if possible, they should induce the Education Department to make it a general subject—a class subject, in all elementary schools. He was not, however, quite sure that he agreed with Professor Silvanus Thompson in the view that it might be desirable to have mono-technic schools, although when, as in the case of Bermondsey, they had a special locality devoted to a special industry, it was undoubtedly the best thing to have an institution devoted to that particular branch, mono-technic and not polytechnic. At Widnes, a district largely devoted to the alkali industry, naturally chemistry was a prominent subject, but there was also a large copper and metallurgical industry springing up in the neighbourhood, and in a case like that it would be impossible to set up a mono-technic school for one subject. There might, however, be several branches, allowing the student afterwards to proceed to that branch which dealt with the subject in which he was most interested. He was particularly interested in Professor Lunge's paper. The professor had been for some time the manager of a large alkali works on the Tyne, and he knew no greater authority on technology than he was, but whether the system advocated by Dr. Witt, of teaching from the effect to the cause was better than the present system of proceeding from cause to effect in the teaching of chemistry he would not venture to say. He understood him to urge that the demonstration should be first exhibited to the student and the lecturer should then proceed, from the demonstrated effect, to show the cause. It was the same principle as that now adopted in the teaching of modern languages, of teaching them orally first, and then allowing the student to master the grammar afterwards. But it was necessary to the comprehension of results that the chemical formula should be known, and therefore the theory should be taught. It was also absolutely necessary that in the teaching of chemistry, other branches of science should be taught therewith. He noticed that Professor Witt said, in his paper, with reference to chemistry, that "it was not the methods of execution which underwent change so much as the principles upon which they were based." As an old chemical manufacturer, he would have taken quite the opposite view. He spoke with great deference in reference to any view advanced by Dr. Witt, but in the alkali industry principles were known, and the difficulty was to put them into practice for commercial purposes, so as to make them a commercial success. It was only by the application of physics, by which the requisite plant was devised, that many principles, long known to chemists, were put successfully into practice. Mr. Snape gave examples of various processes of manufacture in which commercial success had only been possible by the discovery of the precise mechanical and engineering methods which were necessary to put the theoretical principles into effect. Therefore, he could not see how it could be said that it was not the methods of execution that changed, so much as the principle. So far as his experience went, the difficulty of manufacturers was to get their principles put into practical application, and to do that they needed the knowledge of physics and of engineering and technology, which Dr. Lunge, from his practical experience as a manufacturer, and since as a professor at Zurich, so very properly advocated. When his son went to Berlin, to study under the late Professor Hoffman, who asked him this question, "Do you want to be a chemist, or to develop that chemical knowledge which you already have for the purpose of applying it to any particular form of industry?" If he had said he wanted it to assist him in the manufacture of dyes, they would practically have given him little assistance, but when they found he wanted to pursue the study of chemistry for its own sake they gave him every facility. There was no doubt that German chemists obtained their success by getting as thorough a knowledge of the subject as possible, and then trusting to the openings that might present themselves for the application of that knowledge to various forms of usefulness. The question of research demanded much more attention than it had received from English chemists, and it was in that department that the Germans excelled. The illustration given that morning, by Sir Henry Roscoe, of the large colour works where so many eminent chemists were employed was an apposite illustration of his point. The German chemists, in chemical manufactories, tried in their research work to get definite results bearing upon the particular industry with which they were connected, and it was because of that fact that Germany was able to supply its manufactures to countries that should be able to supply themselves. There was no inherent defect in our own people which would not allow them, if the same methods were employed, not only to be abreast of Germany, but even ahead.

Mr. PARKER RHODES said one difficulty under which we laboured was that in all other languages except our own chemistry meant one thing and pharmacy another. A Select Committee of the House of Commons was at present sitting in order to ascertain how it was possible to lessen the danger of petroleum as an illuminant or heating power. That committee had been sitting for three Sessions, and they had not been able to come to any conclusion.

Dr. ERNEST H. COOK wished particularly to refer to the paper of Dr. Gladstone, which had dealt with the teaching of chemistry in evening and continuation schools. He (Dr. Cook) had taught chemistry for a considerable period, and had also endeavoured for some time past to introduce it as a subject into the Board schools of Bristol, and he agreed with Dr. Gladstone as to the difficulty of introducing it into the Board schools of the country. He thought the great difficulty was not owing to the want of ability on the part of teachers in the Board schools or elementary schools, but owing to the very great fault which not only affected the teaching in elementary schools, but the teaching in those schools under the control of the Science and Art Department, and that was what he might call the "overcrowding" of the syllabus. It was evident to any one who had had practical experience of teaching in those schools, that the amount of work required by the inspectors or examiners was far too much for any honest teacher to get through in the time that was devoted in evening schools to the work of teaching chemistry. It was too much to expect a teacher to get through a syllabus which practically embraced the whole field of elementary chemistry, as required by the code of the Science and Art Department—if the teacher illustrated his teaching, as he ought to do, by well thought out and devised experiments. He hoped that one result of this Conference would be to place in the hands of science teachers, and especially teachers of chemistry, throughout the country, some power to modify their syllabus, not only, as mentioned by Professor Silvanus Thompson, to meet the varying requirements of different localities, but also to give them a certain amount of elasticity as to the manner of teaching. In Bristol, where they had tried to get it introduced in the Board schools, the teachers would have none of it—they hadn't the time. In other words, it didn't pay, because they could not get the inspectors to appreciate the amount of work necessary to be put into the subject if it were properly taught, and hence it came about that in Bristol they had not one elementary class devoting itself to the subject. Turning to another point, Sir Henry Roscoe had undoubtedly put his finger upon one of our weaknesses when he said that the manufacturers of England required education, as well as elementary teachers or artisans.

Dr. J. T. DUNN thought that Dr. Armstrong's paper was to be commended for not confining itself to the teaching of chemistry merely, but for contemplating the teaching of general science. If a chemist had received such a general school training, then it would be only a matter of degree how much further he should go on similar lines before specialising himself for any particular industry or avocation —either as a chemical manufacturer or as a teacher in such a mono-technic institution as that at Bermondsey. He assumed that there would be no difference of opinion as to the value for any one who contemplated going into a chemical industry of a knowledge of engineering. Besides those processes to which Mr. Snape had referred, there were many others, the Chance-Claus process of sulphur recovery, for example, for the satisfactory carrying on of which such a knowledge was indispensable, and in which the adaptation of the plant to the object in view was the whole secret of the commercial success of the process. He had had experience on the same river as Professor Lunge, and in those days the least important man in a chemical works was the chemist. The chemist was always a subordinate sort of individual, and one scarcely knew what he was, except that his salary did not amount, as a rule, to more than £50 a year. The manager of a works was as a rule not a chemist at all, but an engineer. Now, the chemical industry of the Tyne was not in the same flourishing condition as formerly, and he thought that fact was not unconnected with the fact that managers of chemical works used to be not chemists, but only engineers. But they would err equally in the opposite direction if they trained, as managers of works, chemists who knew nothing of engineering.

Dr. KIMMINS was much impressed by what Professor Silvanus Thompson had said of the necessity for higher technical education, as in the discussion that point had been lost sight of. The committee which had sat upon that subject in connection with the Technical Education Board of the London County Council had issued a very important report, in which the views of Professor Thompson were exactly expressed. The committee consisted of such experts as Sir Philip Magnus, Professor Ramsay, Dr. Russell, and Dr. Ludwig Mond. In that report occurred the following recommendation :—"That for a certain class of adults there is a need for instruction in certain branches of chemistry, the understanding of which is of direct use to them in their occupation, and that the teaching of chemistry in its application to any industry should be concentrated as far as was possible in a small number of institutions, which should be thoroughly equipped for the purpose and placed under the direction of experts, as in the case of the Leather-tanning School at Bermondsey." That school had been a great success, and further applications for admission had had to be refused; and that the employers appreciated it was proved by the attendance of foremen of works there. Dr. Armstrong rejoiced in the success of the teaching of chemistry in elementary schools which had taken place in London, but it was a very remarkable thing indeed that so few people were attracted to the evening continuation schools in that subject. Dr. Gladstone had pointed out that fact, but the difficulty might be met in the manner which Mr. Cook had suggested that afternoon by some alteration being made in the syllabus. In 1892 he had to inspect the secondary schools in London for the purpose of Mr. Llewellyn Smith's report, and the teaching at that time was far from being of a satisfactory character—largely due to the imperfect equipment of the schools for practical work. The science teacher was often abused, but it was nearly always a case of the limitations of poverty, for they could not teach chemistry unless they had properly-equipped laboratories. The Technical Education Board of the London County Council had equipped 24 laboratories, and provided accommodation for 3,000 students, and the result was that a large percentage of students were now doing good practical work, in both physics and chemistry.

Mr. G. N. HOOPER noticed that Professor Lunge rather deprecated the technical teaching of workmen, but he thought they should rather try by such teaching to remove their prejudices, which were really a considerable impediment to progress. As a member of the Commercial Education Committee of the London Chamber of Commerce, he had found that they could get a fair number of students, and competent teachers, for higher Commercial Education, but they were hampered by the apathy of the manufacturers and merchants, and if that Conference could awaken both manufacturers and merchants to a sense of the importance of this subject it would not have met in vain.

Mr. C. T. MILLIS regretted that more had not been said upon the question of teaching chemistry to workmen. He was particularly interested in that matter, inasmuch as he might claim to have taken some trouble in assisting in the formation of the Bermondsey School. Their work there was divided into two parts—day classes and evening classes. At the evening classes every encouragement, by low fees and suitable hours of attendance, was given to workmen and foremen engaged in the tanning yards at Bermondsey. He would like to have heard from competent authorities some expression of opinion as to whether they were doing wrong—personally, he did not think they were —in encouraging the teaching of applied chemistry to the actual workers in a particular industry. They were perfectly willing to admit that a longer time might be spent in day classes by the sons of employers, and probably better scientific results might accrue from that. At the same time they also felt that beneficial results might accrue to an industry if the workmen were encouraged to try and learn something of the principles which underlaid the practice of the industry in which they were engaged, and he was glad to point out that whilst the sons of employers attended their school fairly regularly, the foremen and heads of departments were allowed "time off" in order to go into the laboratories and pursue certain research work. It was an important point to consider whether they should endeavour to teach scientific principles up to a certain point to those who had not been engaged in any industry or in any works, or whether they should teach the principles of science to those who had already been engaged in the works. They had now found, in connection with the printing trade, that the master printers were awakening to the importance of the subject, and now allowed their apprentices to leave work in order to attend the classes at 5.30 instead of their coming, tired and incapable of work, at eight o'clock in the evening. At the commencement of the school at Bermondsey not the slightest encouragement was received from any manufacturer in the district except one, but as it had gone on, and employers had seen the benefit likely to result, and had become assured of the good work which they could accomplish, they had awakened to the value of the work. He agreed that there was a great amount of apathy amongst manufacturers, and had it not been for the generosity of the Leathersellers' Company their excellent and successful school at Bermondsey would not be in existence to-day.

Dr. L. T. THORNE, speaking as one having had the advantage of research training in Germany and England, and having had some knowledge of educational work in England, and now engaged in technical work, would like to enter a plea for research work in connection with higher technical education. He also considered, with Professor Thompson, that they should divide the work, and recognise that there are different grades of technical education. For certain classes of workers in different industries specific teaching in the technical work of their own industry was most valuable, and this fact not only justified, but rendered necessary the establishment of special schools, or "mono-technic" institutions in certain districts where one particular industry existed. But besides this lower grade technical education it was, in his opinion, of vital importance, to recognise the need of breadth of training in the higher grade technical education, and especially the need of training in scientific research. He had been for some years engaged in two large works, where he had been allowed a very free hand (and not cramped in the way most works chemists were by previous speakers said to be), and he had found no part of his training of more value than his experience in scientific research. He fully recognised the absolute need for training in physics, engineering, &c., for anyone intending to become a technical chemist or works manager, but of even greater importance he considered the training in scientific research. It was to the latter that a man owed his power of grappling with the problems which faced him in the works, whether they be in the overcoming of difficulties in existing processes, the improvement of such processes, or the initiation of new ones. This was not only a *primâ facie* opinion, it was his own personal and practical experience in technical work.

Dr. ARMSTRONG, F.R.S., replying upon the discussion, said he would like to emphasise the remark which fell in the first instance from Sir Henry Roscoe and then from subsequent speakers, and that was that, after all, the command of the position was not so much in the hands of those who were carrying on the education of the country as in the hands of employers. We were as capable of producing good chemists as any other country, but there was no degree of certainty that their labours would be rewarded, or that a place would be found for the exercise of their experience by the employers of the country; the consequence was that we did not attract to our schools those that ought to go to them, and who do go to the corresponding schools in Germany. Such a thing as a chemist in a manufactory paid at the rate Sir Henry Roscoe had mentioned in the case of the colour manufactory in Germany was almost unknown in England. When the day came that English manufacturers respected science—that is to say, when they paid for it well—then manufactures here would prosper, but not before. It appeared to him that they were travelling outside their sphere, because he did not think the present audience was sufficiently representative to enable it to discuss the subject of the particular teaching which should be given. Of course, very much depended upon what they regarded as a definition of a chemist. One gentleman had spoken of chemists employed at £50 a year. Well, they were not chemists. English manufacturers, as a rule, did not employ chemists—they employed "testers," and paid accordingly. A workman did not require to know chemistry at all. He required, however, just that kind of training that he could receive in studying elementary physical science, and to be able to do what he was told. "Mono-technical" schools, such as that at Bermondsey, might render most valuable service in helping to train workmen and foremen, but they could not do everything, and it was essential that those who took command of the industry should receive a thorough scientific training.

Dr. GLADSTONE, F.R.S., said that between the primary schools and the proper technical schools there came the evening continuation schools. In dealing with the latter, his object had been to show what was being done at the present time, and what had not been done, for teaching young people who gained some amount of elementary science in the primary schools, and fitting them for their various pursuits in factories or wherever they might be placed. There was no difference between what had been said by Professor Thompson, and what had been contemplated by himself, with regard to the necessity of special schools or classes for teaching special practical matters. Seeing that there was such good scientific training given in the Board Schools, how was it that there were so few who pursued their science studies in evening continuation schools? That question occurred to him also as he was reading his paper, but the answer was a simple one. First of all, this scientific teaching in the London Board Schools had only existed for a very few years—in fact, ten years ago they might say that there was not any such teaching in London of an intelligent character. That special kind of training was only half a dozen years old, and so these boys were now only just coming into the evening continuation schools: but, more than that, out of the 450 Board Schools in the metropolis only a very small proportion as yet have gone in for this education. But as time went on there would probably be a large army of young people, trained in the elementary schools, who would come to the evening continuation schools on their way to the higher institutions.

THE INTERVENTION OF THE STATE IN SECONDARY TECHNICAL EDUCATION.

By Gilbert R. Redgrave.

While as early as 1833 the State had begun to foster primary or elementary education and to assist it with grants from the public funds, it was not until many years later that the claims of secondary or intermediate education entered the sphere of practical politics. It is true that, owing to the appointment of the Select Committee of the House of Commons in 1835, the art education of this country was aided from 1836 onwards by annual Parliamentary grants, which, beginning in the latter year with a sum of £1,500, amounts at the present time to a total of little short of £320,000 per annum, by far the largest part of which, however, is allotted to the teaching of drawing in elementary schools. General science teaching was first rewarded by Government grants in 1859, and the sum set apart for the science education of the country for the present year amounts to nearly £200,000, disregarding for the time being the large sums received for this purpose under the Local Taxation and Excise Act of 1890.

In the admirable "Historical Sketch" prefixed to the recent report of the Royal Commission on Secondary Education, it is stated that it was not until 1861, when the Royal Commission was appointed to inquire into the condition of nine among the chief endowed schools of the country, that what is now called secondary or intermediate education began to engage serious attention. This Commission, presided over by Lord Clarendon, reported in 1864, while a second Commission appointed in December of that same year, the so-called "Schools Inquiry Commission," presented its report three years later, in December, 1867. The outcome of the first of these Commissions was the Public Schools Act of 1868, while the issue of the second Commission was the Endowed Schools Act of 1869. Among other provisions of this latter Act was the appointment of a permanent body, termed "The Endowed Schools Commission," entrusted with large powers for the better government and management of schools of this character. In 1874 this body was by a subsequent Act of Parliament merged in the Board of Charity Commissioners for England and Wales. Under these public bodies, schemes for upwards of 900 schools have been framed and approved, out of a total of 1,448 endowments in this country, known to be subject to the Acts, but a considerable number of endowments, founded less than fifty years before the passing of the Act of 1869, have until now been exempt from its provisions.

The Elementary Education Act of 1870 had undoubtedly the most far-reaching effects in establishing the primary education of the country upon a sound and systematic basis, and when it becomes necessary to study the question of more advanced instruction, the recent tendency of certain of the public bodies, created under that Act, to provide education for children beyond the limits for which the primary schools were originally designed, must receive careful attention. Schools of the type known as "Higher Grade," "Higher Standard," or "Seventh Standard Schools," have been established in certain of the large towns with the avowed intention of taking up the work of education to a point beyond that at which the elementary school leaves off. As is well said in the Report of the Secondary Education Commission, "these schools, though they have received the name of 'Higher Grade Elementary,' are really secondary in their character, so far at least as regards their higher classes, in which instruction beyond the Standards is given." As these schools can only share to a very limited extent in the grant distributed by the Education Department, they are supported partly by the fees of scholars, but mainly by the grants of the Science and Art Department.

This brings me to the consideration of the principal Government agency for the promotion of secondary and technical education in this country, namely, the operations of the Science and Art Department, and in this connection I desire to speak more particularly of the work of the Organised Science Schools called into existence under that Department. The State first took a part in diffusing a knowledge of the arts and principles of design among the people (especially the manufacturing population) of the country by the establishment in London in June, 1837, of the Normal School of Design. In 1840 the Government decided to extend their assistance to the manufacturing districts, and authorised a grant of £10,000 towards the formation and equipment of schools of design in certain of the larger provincial towns. Ten years later, in 1850, when considerable changes had been from time to time introduced into the management of the school in London, there were sixteen provincial schools of design in Great Britain and Ireland, with about 3,000 pupils under instruction, and in 1852 a so-called Department of Practical Art was called into existence under the Board of Trade to administer these schools, and to promote and foster the general art education of this country. A year later the new Department was much enlarged in its scope, and became from thenceforth known as the Department of Science and Art.

This state of things continued until February, 1857, when the Education Department was constituted to include (*a*) the Education Department of the Privy Council Office, and (*b*) the Department of Science and Art, and these two departments were placed under the Lord President of the Council, assisted by a Vice-President of the Committee of Council on Education. It will thus be seen that the Department, originally organised to deal with the art work of the country, was subsequently entrusted with administrative machinery by which grants are distributed in aid both of science and art. Its annual grants, began as we have seen, to be made as far back as 1837, and though these grants were not originally made to schools, except such as those in which art alone, or later those in which science in conjunction with art was taught, yet, as pointed out in the Report of the Secondary Education Commission, the tendency of more recent "legislative and general changes in education has been to render them grants to scholars in schools."

The work of the Science and Art Department and the syllabuses of its examinations originated with the requirements of the art school, the art class, or the evening science class, and the examinations have from time to time been modified to make them more generally applicable to the needs of scholars in schools, rather than to those preparing for an art designer's career, or to those attending the night classes at mechanics' institutions and schools of a similar type for whom they were, as already stated in the first instance chiefly intended. It is, indeed, largely owing to the new type of students taking advantage of its grants in the higher grade schools in provincial towns, to which reference has already been made, as also in endowed schools or grammar schools, that certain recent developments in the work of the Department, culminating in the establishment of the so-called organised science schools, have been introduced, and it is to this aspect of its operations as bearing on a State system of secondary education that I desire to chiefly dwell upon the present occasion.

At the very inception of the scheme of State grants in aid of science teaching in 1861, there were ready to hand, besides the isolated classes in architectural and engineering drawing, physics, and chemistry in some of the chief mechanics' institutes, a certain number of schools scattered through the country in the nature of engineering schools, navigation schools, or trade schools in which a considerable amount of time was devoted to science teaching, some of these schools being due to the early action of the Department, from 1853 onwards, and these were prompt to avail themselves of the examinations and grants offered to them by the Science and Art Department. In the course of time, as teachers became trained, classes in the various subjects of science were multiplied, being very largely in the nature of evening classes, and one of the reproaches levelled against the work in connection with South Kensington was the sporadic character of many of these classes and the want of continuity and completeness in the course of study pursued by those who were trained in them.

The chief attempt to remove these objections was the institution of the "Organised Science Schools," or secondary schools in which a definite course of science work was enjoined, and in which the curriculum laid down was such as to ensure a due sequence in the subjects studied and in the correlation of one branch of work with another.

The name adopted for the schools of this type, though it is sufficiently explanatory of its object, is not free from objection, being no doubt cumbrous and in some of its applications misleading, but as the appellation in question is about to disappear we need not now discuss it further.

Various advantages in simplified registration and in capitation grants were held out to induce school authorities to avail themselves of these special schemes, and the organised science schools under the Department have steadily increased both in number and in importance. Very early in their history, it became manifest that these schools would embrace institutions which were originally of widely differing types, for while, on the one hand, the scheme was adopted by many of the higher grade schools, to which attention has already been drawn, frequented almost entirely by ex-standard scholars of the public elementary school, the course was shown to be readily applicable to the modern side of the grammar school, and, with slight modifications, to the day technical school of still more recent growth. The tendency in the grammar school was to press for a reduction of the time devoted to the science and art teaching, and in the technical school the literary teaching was in some cases brought down to the vanishing point. It soon became evident that schools of this character, conducted upon the lines laid down by the Department, were admirably adapted for the education needed by the middle classes of our large manufacturing towns, and that by the introduction into the prescribed courses, of certain modifications, such schools might become the State secondary schools of the future, carrying on to its necessary conclusion the excellent education afforded by the best Board schools, and serving to provide such a groundwork in science as would furnish the soundest possible preparation for the technical high school, or science university. My intention is now to indicate how these various aims are provided for in the amended curriculum of the State science school.

The Secondary School Commissioners in their recent report, have well defined secondary education, which is inclusive of technical education, as "education conducted in view of the special life that has to be lived, with the express purpose of forming a person fit to live it." A good type of a school providing this education, is stated to be "less literary than the grammar school, less theoretical than the science school, and distinguished from both by its functions being mainly industrial." The modern science school, as I understand it, draws its population from the lower middle classes, almost entirely from the children of parents who cannot afford to keep them at school beyond the age of 18. In the case of a very small number of its students provided with bursaries and scholarships, or the children of more well-to-do-parents, it may be possible to proceed to the technical college, but the large majority of the students will end their education here, and will quit the school to earn their own living. This fact must limit the course, in most cases, to three years, but it becomes possible, by the provision of a fourth year's course, to meet the requirements of those who will matriculate for the university, or who will complete their education at the technical college.

The work of the so-called elementary course of the science school is designed to extend over two years, during which a thorough progressive course of education in science, combined with literary and commercial instruction, must be given. It is an important feature in this part of the scheme that students whom the inspector reports to be unfitted for the work will be excluded. The elementary course, as laid down in the Directory of the Science and Art Department, comprises five obligatory subjects of instruction, namely, mathematics, elementary physics, including the fundamental principles of mechanics (theoretical and practical), elementary chemistry (theoretical and practical), freehand drawing, and elementary practical geometry. It is stipulated that, while the course may extend over two years, all the subjects must be taught in each year, the instruction in the second year being more advanced than that of the first year. It is intended that the teaching should be such as to form the basis of future studies in science, and the students, during this part of their education, are not submitted to examination, but their work is tested by the inspectors of the Department in the course of frequent visits. Not less than 13 hours per week must be allotted to the instruction in the above obligatory subjects of science and art, eight hours of which must be devoted to the teaching of subjects other than mathematics, and not less than 10 hours per week must be set apart for the literary subjects, which may include two hours given up to manual instruction, or in the case of women students, to cookery and needlework. It will thus be seen that 23 hours per week must be devoted to subjects of the time-table, over which the Department exercises direct control, and further regulations apply to the length of the lessons, the number of students under each teacher, the marking of the registers, and to other matters of detail which need not here be specified.

On the completion of the elementary course, the intention is that the work of the students should be specialised in one or other of a series of advanced courses, several specimens of which have been drawn up suitable to the needs of students who may desire to devote their attention either to physics, mechanics, or biology. It is pointed out that other special advanced courses, such as for mining and agriculture, may be sanctioned, but it is necessary that they should be previously submitted to the Department for approval. In all these courses a considerable amount of latitude is allowed to the teacher, provided the instruction is sound, satisfactory in amount, and combined with proper practical work. In the case of the advanced courses, certain obligatory and optional subjects are laid down and, as in the elementary stage, sanction is given to extend the work over two years, but the second year's curriculum must be submitted to the Department for approval. During this second year the time devoted to literary subjects and manual instruction may be curtailed to six hours per week.

The education of women students is specially considered, and in their case instruction in certain subjects of biology may be substituted for physics in the elementary course, and where this is done a special advanced course has been drawn up for their use. In many of the existing schools both sexes are being taught together with excellent results.

A liberal scale of payments has been devised for these schools, based partly upon capitation grants upon individual attendance, partly in the form of a variable grant dependent upon the result of inspection and partly as a grant for practical work done in suitable laboratories. In the case of students in the advanced course, payments are made upon the results of examinations conducted by the Department in the ordinary subjects of science and art, and payments may also be claimed on account of manual instruction or for the needlework and cookery of the women students.

It has been found that in a well-equipped science school, properly staffed, and attended by students of suitable age, who have been carefully trained in accordance with the prescribed syllabus, that grants averaging from £4 to £6 per head can readily be earned, and it is estimated that schools coming under the scheme can in certain cases obtain in grants more than three-fourths of the total expenditure per scholar. Of course it is not intended that the State should pay the entire cost of this education, but it has been publicly stated that in certain of the higher grade schools the grants from the Science and Art Department are sufficient to cover all the expenses except the rent.

From this brief outline of the regulations for these schools it will, I think, be evident that we have here all the conditions needful for the suitable training of the large majority of the young people of both sexes in the country, who would in the natural course of events enter the secondary school. In the case of a relatively small proportion of the children of the upper middle classes, who may look forward to entering the university, there is the classical training of the grammar school and the public school, existing upon lines which have been pursued from time immemorial, and concerning which I have no desire to speak at the present time, but the curriculum of the grammar school is eminently ill-fitted for modern requirements and for the training of the vast majority of the children of the middle classes who have to look forward to an industrial or a commercial career. Something of the nature of the German Real-Schule, but with a far larger proportion of practical science work and manual training should, I am convinced, serve in the future as our model for the secondary school in this country, and I believe that it is quite possible to expand the scheme of the State science school, such as I have described it, so as to embrace all those branches of a modern education, whether literary, scientific, or commercial, which can possibly be required by young people between the ages of fourteen and eighteen. I look forward to the time when each large manufacturing town, and every county town of importance, will possess its State-aided and State-inspected modern school, and I am convinced that in the organised school which I have attempted to describe we have all the necessary elements of the institution in question. Each of these schools will of course be adapted in its details to the special needs of the locality in which it is situated.

I have purposely avoided all mention of the details in the work needed for different types of schools, but it would be easy to show that in the case for instance of a commercial or an agricultural school, certain readily introduced modifications in the curriculum would convert this or that section of the school in the one case into an agricultural division, in the other into a commercial school. For schools of the latter type we have excellent models in Antwerp, Vienna, and certain other continental cities, where the youth is trained to be a clerk almost as if he were in the counting-house of a samples, analyses them in the school laboratory, tests their relative values, fixes the prices, sends invoices and corresponds with imaginary agents, manufacturers, and travellers, in several languages, and he sees in the school museum fine collections of commercial produce from every part of the world. We have really no example in this country of a commercial school established on modern lines. Agricultural schools already exist in England and will furnish useful types of the class of changes which will have to be introduced in the syllabus in order to render the State-aided school suitable for a specialised training in agriculture.

There are many other directions in which the school or sections of the school may have to be modified, since it is quite evident that no merchant's office. He sends and obtains narrow or rigid curriculum would suit every case, and to my mind the great value of the syllabus consists in the obligatory nature of a fixed amount, both of literary and scientific instruction, with the power to take up other voluntary subjects capable of giving a special direction to the work of the school.

I wish it to be clearly understood that I have purposely here omitted all reference to the other directions in which the State intervenes in order to aid the science and art work of the country, namely, in the system of evening classes and in the fully equipped school of art or in the simple art class. The art work may be disregarded, as it forms but one small branch of technical education. The science work, however, stands in a wholly different position, and the training in practical science and in manual work, which has been largely stimulated by State grants, must, I think, be regarded as among the most important and valuable of the results of State intervention in secondary technical education.

WEDNESDAY MORNING, 16TH JUNE.

SECTION A.

Major-General Sir JOHN DONNELLY, K.C.B., in the chair.

THEORY AND PRACTICE IN TRADE TEACHING.

By SIR PHILIP MAGNUS.

Of the City and Guilds of London Technical Institute.

The experience acquired during the few years since technical instruction was first generally introduced and made supplemental to trade practice, has enabled us to formulate certain principles applicable to the teaching of trade subjects. The material now exists for a new chapter in Pedagogy, which, if not yet written, may at any time be added to the science of education. The difficulty of determining the true relation of theory and practice in teaching the technology of any trade is shown by the Regulations of the Science and Art Department which apply to the teaching of science in its bearing upon trades, and in the Technical Instruction Act, which expressly forbids the teaching of the practice of a trade in any technical school. The words of the Act are, technical instruction "shall not include teaching the practice of any trade or industry or employment."

It has become a recognised principle of technical training that a trade is best learnt by actual practice in the factory or shop, and so strictly has this principle been adhered to, that the establishment of schools similar to the Apprenticeship Schools of France and the *Fachschulen* of Austria and of other countries has been discouraged by the best authorities on the question of technical education. Nevertheless, it has been found necessary to approximate so closely to the teaching of a trade in some of our technical classes, that local authorities have frequently been in doubt as to whether they have infringed the Act, and the Government has been obliged to give a very broad and liberal interpretation to it, to satisfy the just and proper demands of technical schools.

There is also considerable difficulty in indicating the kind of theory to be taught in a trade school. The courses of instruction prescribed by the Department in the Directory for science were intended to meet the requirements of students engaged in different sections of industry. But, although such courses of instruction have been largely followed by all kinds of artisans, a protest has been continuously heard that the syllabuses of instruction are ill-adapted to the workmen's needs; and we know that the instruction has failed to reach thousands of workers in some of our largest and most important industries. This fact was brought prominently under my notice when I was asked, sometime since, to ascertain what proportion of the candidates at the technological examinations succeeded in qualifying for the full certificate by having passed certain examinations in allied branches of science under the Science and Art Department. The inquiry showed that less than 17 per cent. of the successful candidates were so qualified, and in some industries, notably in the textile trades, the proportion was much smaller. It appears, therefore, that for the purposes of technical education, more particularly as adapted to workmen, special methods have to be considered even in the teaching of the theory, or principles of science underlying the practice of any trade.

One of the most interesting papers it has been my privilege to read, is an article contributed to the *Edinburgh Review* in 1824, which shows how clearly its distinguished author, the late Lord Brougham, foresaw many of the difficulties we now experience. Lord Brougham, in the article to which I refer, quotes with approval from the prospectus, published in 1821 by the Edinburgh School of Arts, the following passage:—

> "The great object of this Institution is to supply, at such an expense as a working tradesman can afford, instruction in the various branches of science which are of practical application to mechanics in their several trades, so that they may the better comprehend the reason for each individual operation that passes through their hands, and have more certain rules to follow than the mere imitation of what they may have seen done by another. It is not intended to teach the trade of the carpenter, the mason, the dyer, or any other particular business; but there is no trade which does not depend, more or less, upon scientific principles; and to teach what these are, and to point out their practical application, will form the business of this establishment. He who unites a thorough knowledge of the principles of his art with that dexterity which practice, and practice only, can give, will be the most complete, and probably the most successful tradesman."

It would appear, however, that more specialised instruction having been required, the students at the mechanical lectures of this school proposed to form themselves into separate classes, and they selected a working joiner, by name James Sale, and David Dewar, a working cabinet-maker, from among their fellow-students to give instruction. But even this arrangement was not free of difficulties, and Lord Brougham goes on to say: "The experience of the first year, and particularly the fact that the students were of no less than forty-eight different trades, convinced the directors that the best plan was to limit the lectures to the general principles of those sciences which are of universal application to the arts, and not to attempt, as had at first been intended, teaching the principle of the arts in detail."

Here the matter was left. The City and Guilds Institute has been trying during the last 17 years, with I hope some success, to solve the problem which was left unsolved by Dr. Birkbeck, Lord Brougham, Mr. Galbraith, and other pioneers of technical education. At the Edinburgh School of Art it was finally arranged that the lectures should be "strictly confined to such objects of science" as would be "useful to workmen *in the exercise of their trade*," and if we adopt this principle we cannot go far wrong.

I cannot hope, in this short paper, to treat with any attempt at completeness what may be called the methodology of trade teaching. I can only throw out a few suggestions, and indicate some of the difficulties it involves. The subject, however, is well worthy of the careful consideration of the educationist as a problem full of interest and of great importance.

Let us consider, first of all, the extent to which practical work may legitimately enter into trade teaching. Now there are certain branches of trade and certain circumstances and conditions in which, notwithstanding all that may have been said to the contrary, the apprenticeship school—that is, a school in which the practice of a trade is completely taught, is a useful and almost a necessary institution. In many art industries this is so. An apprentice will learn wood-carving far better in a school than in a shop. The art requires no expensive tools, to be obtained only in the shop, and the supervision and suggestions of the school teacher afford help which the young apprentice cannot equally well obtain in the commercial shop. Of engraving and inlaying, of metal-chasing and enamelling, of china-painting, basket-making, embroidery and artificial flower-making, and of very many other "arts and crafts" as they are commonly called, the same may be said—that the practice of the trade may properly be taught in school. Then, too, an apprenticeship school often affords a very useful, if not the only means, of introducing a new or of recovering an old industry. In a country like Ireland, where trade has languished, the establishment of such schools for the teaching of carefully selected trades might, and probably would prove most serviceable. In many rural districts, too, where the villagers earn a very scanty livelihood as agricultural labourers, new industries, requiring few tools and only cheap material, may be taught, thus increasing the prosperity of the district and improving the condition of the workers. In Cambridgeshire basket-making is being now so taught, and an improving trade is likely to be localised in that county. In many parts of Southern Germany similar trades are extensively taught, and the position of the agriculturist is thereby materially improved. But the instruction, in such cases, must go beyond the limitation imposed by the Act; for unless the pupils are really taught the practice of the trade, so as to be able to produce saleable articles, the teaching would fail of its purpose. There are other cases in which, it seems to me, the practice of a trade may be legitimately taught in school. My attention has recently been drawn to the fact that the tailoring trade has for many years suffered from foreign competition. I mean the competition, not of imported goods, but of imported workmen. This complaint does not apply so much to "cutters," who occupy a higher position in the trade, as to the rank and file of the work-people who are engaged in sewing and putting together the garments that are cut out for them. There seems to be at present no way of training competent work-people for this large industry. The conditions under which the work is done do not admit of anything approaching to the apprenticeship system, nor do the young people who want to learn the trade have any chance of acquiring the necessary proficiency and dexterity in the ordinary shop. The result is that foreigners are largely employed, many of whom have gained the necessary skill in a tailor's school. Now I am told that the want of such schools is much felt in this country, and it is believed that it is only in such schools that lads can be trained as competent and efficient workmen. Yet in accordance with the strict provisions of the Act, a school of this kind would be unable to receive any grant in aid from a local authority.

The instances I have quoted are, I admit, of an exceptional character, and might be easily provided for by a clause giving discretionary powers to the central authority in the interpretation of the Act—powers which, I am bound to say, have been already wisely stretched in the best interests of technical education, by the Science and Art Department.

To the great majority of industries, however, the rule unquestionably applies that the practice of the trade is best acquired in the factory and shop, and that the instruction of the technical school should be supplementary only to the experience obtained in commercial work. By this principle nearly all our technical classes are regulated. Nevertheless, in many of these classes, something that approximates very closely to the teaching of a trade is recognised as necessary. The difference, more or less clearly defined, is, however, sufficiently marked to distinguish the practice of the shop from that of the trade school. Anyone going into a technical class for plumbers, printers, or bookbinders, or into the fitter's shop of a school for engineers, or into one of the well-equipped weaving sheds found in so many of our textile schools in Lancashire or Yorkshire, would be inclined at once to assert that the practice of a trade was being taught in such schools. Nevertheless it is not so, or is not necessarily so. The school is fitted with much of the same machinery and tools as is found in the factory or shop; and so indispensable is such equipment, that a large part of the machinery is frequently supplied by local manufacturers, who are themselves interested in the training the school provides. In our weaving schools are found looms of various kinds with all the incidental machinery; in our printers' schools we have founts of type; the best of our boot and shoe class are furnished with the different machines is use by those engaged in one or more of the ten or twelve sections into which the manufacture is split up; our plumbing classes are supplied with furnaces, and with the necessary tools for the joining of pipes and the bossing of lead, and so on with a large number of other trades and industries. To what end, then, are all these tools and appliances employed in the technical school, if the teaching of the practice of the trade or industry is forbidden by the Act? The answer is that they are used and are required to show the student how certain processes are performed, and to enable him to perform those processes himself. The difference between the use of such tools in the shop and in the school is, that in the shop the apprentice or young artisan acquires slowly, under considerable difficulty, and frequently without any explanation of the why or the wherefore, the knowledge how to use the particular machine or appliance; and once having learnt it, he is kept working at it, so as to gain skill and rapidity of execution in its use. In the school, on the other hand, he learns leisurely how the tool is used, the principles of its construction, the errors to avoid, and the means of rectifying them when they occur, the nature of the material to be wrought, and the means of distinguishing different qualities of such material; and having learnt all this, and having acquired a certain degree of manipulative skill, he is not expected by constant repetition of the same process to aim at that rapidity of execution which is indispensable for trade purposes, but is allowed to pass on to the explanation of the use of some other machine and to the learning of some other process. It will be seen, therefore, that although a technical school may be equipped almost as completely as a trade shop, the equipment serves a very different purpose. Its object is the production of intelligent work-people, and not the production of saleable commodities. That goods may be produced is an incident only in the production of intelligent artisans. The practice a student obtains in a technical school is not intended to give him that complete mastery and rapidity of execution—the result of constant practice—which can be acquired only in the shop or factory, where work is done on commercial lines, but rather to enable him to understand the appliances of his trade, and to use them with care and judgment. Nor, indeed, can the technical school, how completely soever it may be equipped, afford that special training in adapting means to ends, in economic working, and in the appreciation of the commercial importance of detail, and of the true value of time, which is acquired in the shop.

We see, therefore, the uses and the limitation of trade practice in technical instruction, and what the Technical Instruction Act really requires is that whilst the school shall afford, by the completeness of its equipment, every facility, within such limitations, for trade practice, those limitations shall not be transgressed. It is in the apprenticeship school only, where efficient workers are produced—workers who on leaving the school can at once find employment owing to the skill and dexterity, there acquired, that the teaching of practice exceeds the limitations imposed by the Act.

It will be seen that the equipment of a technical school for trade teaching is necessarily expensive, even although the object of the instruction is different from the training of workmen in the practice of the trade. A large number of our technical classes are still inadequately provided with the necessary apparatus, and the instruction is consequently too theoretical, and the students lack the opportunity of applying in actual practice the principles they learn. Every year some improvement in this direction is noticed, and the requirements of our technological examinations, which are becoming more and more practical, are helping to make the teaching more practical also. In the early developments of trade teaching it was thought that the practice could be acquired in the shop, and that it was sufficient to teach the theory in the school. But it is now recognised, that whilst what we may call trade-practice may be best acquired in the shop, the application of the theory must be taught in school, and that a sufficiency of tools and appliances is needed for this purpose. The Germans whose educational perfections are so frequently referred to, are still in the elementary stage of trade teaching. But they are beginning to recognise the value of practical work and the necessity of furnishing their schools with suitable appliances, and it is only the want of funds available for such purposes that prevents many of the German schools for artisans from being as well equipped as our own.

When we come to consider what we mean by theory in trade teaching, we are also met by difficulties. It might have been thought, and indeed was thought, that ordinary instruction in physics, chemistry, and mechanics, would form the best preliminary training for artisans engaged in different trades. But experience has shown that this is not so. Artisans require to be taught by special methods those principles of science which are directly applicable to the industry in which they are engaged. This requirement makes the teaching of science to artisans a very difficult problem, and necessitates a special training for those who are to give such instruction. For many years the City and Guilds of London Institute has been brought face to face with the difficulty of this problem. They have tried to solve it in various ways. Latterly, they have endeavoured to induce apprentices, or young artisans, to take a preliminary course of instruction in which the principles of science are presented to them in relation to the practice of their trade. This experiment in trade teaching has proved fairly successful. Preliminary courses have been arranged in electrical engineering, in which the simpler problems connected with the fitting of electric bells, and with wiring for electric lighting, have been made to give examples illustrating some of the more important principles of electricity and magnetism. Similar courses have been arranged for apprentices engaged in certain branches of the building trade. In plumbing, for example, in which subject instruction, to be of any value in supplementing the practice, must deal with the principles of science applicable to the trade, young apprentices have been found to be particularly deficient in the knowledge of scientific method. The efforts of the Institute to improve the instruction given in the numerous classes supported by local authorities, and affiliated to the Institute, have been singularly successful. The preliminary courses of instruction, judging from the attendance of apprentices, appear to have supplied a distinct want, and the teaching has been of such a kind that the experiments illustrating the principles of science with which the young plumber ought to be made familiar have been taken from the plumber's daily practice. It is only a well-trained and well-educated teacher who can give such instruction. In my address at the opening of the Finsbury Technical College, in 1883, I said: "The teacher who is to inspire confidence in his artisan students must address them in the language they understand.... Indeed, the technical teacher ought to be so constituted as to be able to keep one eye on the general principles of science, and the other on the industry which his pupil intends to follow." Where the teacher possesses this educational squint, so to speak, the instruction is found to be appreciated by the young apprentice; but teachers trained to give such instruction are not easily found.

The teaching of the theory of any particular trade will be more satisfactory, and will be attended with less difficulty, when the young apprentice leaves the elementary school with some knowledge of experimental method and some skill in applying it. The way might be much better prepared than it is for technical teaching. The School Board for London has been doing excellent work in its science demonstrations, which will facilitate technical teaching in the future. Other school boards are, I believe, doing likewise. But the consideration of this question would take me too far from the immediate subject of my paper. I want to show only as regards the theory that enters into trade teaching, that for the purposes of technical instruction in trade subjects, the principles of science must be taught in their special application to the trade, and must be illustrated by examples with which the young apprentice is familiar, and by experiments which he would be likely to need in his ordinary work. You will see, therefore, that the teaching of the theory of any trade must be made to illustrate the practice, just as the teaching of the practice must be made to illustrate the theory. For such teaching, a sufficient supply of apparatus and appliances is a first requisite, but the machinery and tools employed in a technical school are used with different objects and with a different intention from those of the factory or commercial workshop.

The Technical Education Board of the London County Council has appointed a committee of experts to enquire into the existing facilities for technical instruction in connection with the different branches of the building trades, and as these trades are essentially practical, I hope, as one of the results of the enquiry, that some additional light will be thrown on the problem I have been considering.

Many interesting facts and conclusions have been derived from a similar enquiry, undertaken by the same body, into the best methods of teaching chemistry for trade purposes. There is, indeed, a wide field still open for enquiry and investigation by educational authorities; and whilst it is evident that the preparation of schemes of instruction must be left to such authorities, or, to quote again Lord Brougham, whilst "it is conceived that persons of education are better able to determine what course of instruction is best fitted to attain the objects in view," valuable help may be obtained from those engaged in the trade, in solving some of the problems that are still full of difficulty in trade teaching.

THE TRAINING OF TECHNICAL TEACHERS.

By Sidney H. Wells,
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One of the most marked features of the recent development of technical education is the growth of facilities for instruction in what are termed "technological" or "trade" subjects. During the ten years prior to 1896 the number of separate classes registered by the City and Guilds of London Institute increased from 262 to 1,120; while in half that time the number of students more than doubled, the total last year being nearly 27,000. The programme of the Institute for the current session provides for examination in no less than 68 different subjects, 63 of which are directly connected with important practical industries. Large as these figures are they do not include all the subjects in which classes for imparting distinctly trade instruction are held, as nearly every technical school or institute conducts special classes suited to the particular needs of its locality. These include, for example, such subjects as horticulture and agriculture, tailoring and upholstery, artificial flower making, pattern making, smiths' work, and many others not included in the City and Guilds Institute programme. It is, moreover, certain that however large the present supply may be as compared with ten years ago, the next decade must mark an equally great advance if the trade workers of our country are really to be provided with efficient technical education.

From what has been already said it will be understood that this paper refers only to instruction in distinctly trade subjects, and not in technical subjects generally. Admission to these is primarily, and in some institutes entirely, confined to *bonâ fide* workers in the trade concerned, this qualification being compulsory for all students upon whom grants are claimed from the City and Guilds of London Institute.

The greatest of all difficulties in connection with such classes as these is undoubtedly the provision of satisfactory and efficient teachers. The larger technical institutes are aften asked to recommend teachers, and cases are not infrequent where suitable men are actually bought at high prices from one town to another in order to conduct classes. In other cases advertisements have quite failed to bring suitable applicants, while it is a common condition to find the successful teacher engaged for four, five or even six evenings weekly at different institutes. Indeed it is probably the case that many centres cannot conduct classes for want of teachers, while it is certain that many others fail to make classes successful owing to the teachers being insufficiently qualified. The wonder is not that some classes fail, but that so many have succeeded, for if any vital matter has been overlooked and neglected it is surely that of the training of the teachers.

What, then, are the essential qualifications of a teacher of technical classes?

The first and most natural is that he should possess a practical knowledge—acquired in the factory or workshop—of the subject to be taught; the second, that he should possess a sound knowledge of the elements of the arts and sciences applicable to the subject; and the third, that he should be able to impart his knowledge to others, to arrange a syllabus of instruction, to manage a class—in a word, to teach.

The first of these conditions is apparently the most easy to satisfy, and of its absolute importance there can be no question. Those who have had experience in such matters will know what great value the trade student attaches to the practical knowledge and position of the teacher, and how he is attracted by the man of recognised experience and skill, as much as he is repelled by the absence of these qualities. But here a very real difficulty presents itself. There is a growing feeling that a man cannot teach efficiently after working hard all day at his trade, the suggested remedy for which is to remove him from the factory or workshop, and let him devote his time entirely to teaching. But in doing this he gradually loses that very qualification which is regarded as essential, for he is no longer able to keep in touch with his trade, or to gain experience of its new methods, processes, or machines, and he very soon ceases to be regarded as a "practical man." This may not be of equal importance in all trades, but in the majority of cases, the loss of practical qualifications is probably only a question of time. On the matter of working all day and teaching in the evening, the author may mention that he knows six teachers of trade classes who teach from three to six evenings per week each, and in all cases after working at their respective trades during the day. Perhaps when the supply of good teachers is greater, this condition of work will cease, for it can scarcely be permanently efficient.

The second qualification—that of a knowledge of the arts and sciences connected with the subject—does not, of course, apply with equal force to all trades, and depends also upon whether the teacher's work is limited to workshop instruction, or includes the conduct of the lecture or theory class. Such a subject as plumbing, for example, including as it does something of the sciences of chemistry, physics and mechanics, requires a wider range of knowledge than, say, plasterers' or smiths' work. The present generation of trade teachers have had to gain their theoretical knowledge in evening classes, by no means an insufficient medium, provided the course of study is sufficiently wide, properly co-ordinated, and continues for a long enough time. But how rare are the practical men who have taken such a course as this will be apparent to all who have tried to obtain them. In some of the newer subjects of trade instruction they are unobtainable, and one is forced to be content with the essentially practical man, who has never attended a class or undergone an examination. The author has had this experience in three important subjects within the last two years, and others have probably met with the same difficulty. Not that the certificated teacher is by any means always the better, or the uncertificated one incompetent. In cases known to the author the teacher of a trade class failed to pass the examination, while three of his students were successful, two of them gaining medals; and in another the class which had been large and successful under a purely practical teacher fell to pieces under a teacher whose theoretical qualifications were all that could be desired.

The author is aware that experiments have been made by the Plumbers' Company in sending selected practical plumbers for a course of theoretical training at a university college with a view to becoming teachers, but he believes the time was quite insufficient for anything like a proper course. Such a plan obviously has very much to recommend it, but the chief difficulty would appear to be in the men being spared by their employers for a sufficient length of time, while it is not improbable that they are less able to assimilate knowledge when crowded into a few weeks or months than when spread over several years, as in evening classes.

Much of what has been already said applies also to the qualification of ability to teach. How often it is that the man with ample knowledge of both theory and practice is unable to impart it to others, and fails altogether as a teacher. Sometimes it may be due to want of interest and enthusiasm which nothing can cure, but more often it is want of method, of inability to arrange the work in its natural sequence, of too great haste and lack of clearness, and of faults in elocution, all of which it is possible to improve.

Owing to the difficulties which the author has himself experienced in obtaining suitable teachers, and the belief that the general demand for teachers was quite in excess of the supply, he has for some time given attention to methods for meeting the deficiency. At the commencement of last session he formulated a scheme for the institution of scholarships for training instructors in trade subjects at the Battersea Polytechnic. Scholarships were offered in each of the trades of bricklayers, carpenters and joiners, masons, plasterers, plumbers, and painters and house decorators. The scholarships gave free admission to evening classes in approved subjects for two, three, or four years, with the provision of text-books and materials. The holders were to be under thirty years of age, to be practically engaged in one of the trades mentioned, to promise to attend at least two evenings weekly for not less than two years, and to undergo examinations as required.

It was understood that they would receive special attention from their teachers, and that during the last year they would receive instruction in matters relating to the conduct of classes. Should occasion require, the scholars would, if qualified, be engaged as temporary instructors, and in the event of vacancies for permanent instructors they would be given the preference over other applicants.

This scheme having come under the notice of Sir Philip Magnus, he was able to obtain from the Plasterers' Company a grant of money for increasing the value of the two scholarships offered for plasterers' work, this being one of the subjects for which there is much difficulty in obtaining teachers.

Of the twelve scholarships offered only nine applicants were found suitable, namely three in carpentry and joinery, two each in masons' work and plumbing, and one in plasterers' work and painters' and house decorators' work. Two of the scholars relinguished their scholarships within a month; but the others attended regularly for the classes prescribed, underwent the examinations, and generally acquitted themselves well.

The scholarships of these seven students will be renewed next year and afterwards until they have completed the course of study agreed upon, provided they continue to be satisfactory. In all cases they are required to attend classes in subjects of art or science connected with their trade in addition to the regular trade class, and the scholarship is only tenable while they continue working at their trade during the day. In the last year the scholars will be expected to attend classes in elocution, and to act as assistants to some senior teacher whose methods of teaching are deserving of imitation. They will also receive a few special lessons of a thoroughly practical character dealing with such matters as the arrangement of courses of study, the management of classes, and methods of teaching, and will be expected to draw up syllabuses of work, and to give practical lessons before a teacher qualified to criticise and advise. Other scholarships will be awarded in the coming session.

Of the ultimate success of such a scheme as this it is impossible to do more than prophecy, but the author has strong hopes that it will prove successful, and will produce teachers of good all round qualifications. One difficulty would seem to be in influencing the character of the work of the scholar in the workshop or factory, and in ensuring its sufficiency, but this can partly be met by selecting scholars who are employed by good firms, or something might be done by enlisting the co-operation of the employers. Considerable time is needed for such a training as suggested, but it is difficult to see how this can be avoided if the practical experience in the shop or factory is to be gained concurrently with that in the classes, a condition which the author regards as essential to success.

The author ventures to suggest that some scheme of this character might be adopted in all our large technical institutes, and that in fact it would be a good thing if at least one student-teacher could be attached to every trade class throughout the country. To further ensure its success, it would appear desirable that the scholarship awarded should include a money payment in addition to free education, and he strongly urges the consideration of this matter upon the London Technical Education Board, the technical committees of boroughs and county authorities, and other bodies interested in technical education. After all, is there any subject more important than that of the teachers who are to train the workers of this country in the scientific principles and practice of the industries in which they are engaged? The teaching of subjects of science, art, commerce, and domestic economy is fairly well provided for, but in that of technology the demand is considerably in excess of the supply, and fortunately for our industries the demand is constantly increasing. The syllabuses of instruction and examination are gradually being widened to include a requisite knowledge of the arts and sciences connected with the industries concerned, and efforts are made to induce trade students to attend classes in certain subjects of art or science in addition to the technical or trade class. It is probably not too much to say that these efforts will largely be futile until the teachers who have no knowledge of these subjects themselves, and are not in sympathy with and often opposed to their introduction, are replaced by others who can best show the value of a thorough course of training by their own position and work, and can assist in imparting it to their students.

Mention should be made of a method of conducting technical classes which exist in some institutes where the teaching is carried on by the professional man or teacher in conjunction with a workshop instructor. For example, classes in plasterers' work, and painters' and house decorators' work would be taken by practical teachers engaged in the trades under the immediate direction and with the assistance of the art master, or classes in brickwork would be conducted by an architect assisted by a practical instructor, the lectures and general supervision of the workshop classes being undertaken by the architect. But such an arrangement is obviously somewhat costly, and its efficiency depends largely upon the training and qualifications of the art master or architect. Generally speaking, this class of teacher is wanting in practical experience, and the arrangement is obviously not adaptable to all subjects.

In conclusion, the author would desire to express regret that pressure of work has prevented him dealing with the subject with more care and detail than has been possible in this paper. He believes that the great importance of the subject will be generally acknowledged, and he hopes that its consideration by this Congress will make for the further development and success of the great work of technical education with which it is so closely concerned.

Mr. C. J. WOODWARD (Birmingham) said there was one paragraph in Sir Philip Magnus' paper to which he had paid particular attention. It was this: "It might have been thought, and, indeed, was thought, that ordinary instruction in physics, chemistry, and mechanics, would form the best preliminary training for artisans engaged in different trades, but experience has shown that this is not so." He would be glad to hear the grounds for that statement. He had been engaged in teaching for many years, and amongst his classes were many of those who had been engaged in trades, and it had been his experience that instruction in the principles of science—not exactly pure science, and yet science—without any special application to particular trades, had been very serviceable indeed, and he was not sure whether it had not been even more serviceable than if it had been arranged for particular trades. He presumed, for instance, that the science of acoustics would not be regarded as pre-eminently suitable for a brass-founder or electro-plater, and, certainly, the connection was not easy to see, but one of his students, an electro-manufacturer, attended a course of lectures on acoustics, and he introduced some dinner-gongs which had been very successful. To give another instance, another pupil had found that to mix certain sugars was a bad thing, because they became unsaleable. His knowledge of chemistry induced him to set to work, and to investigate the problem, and he soon found that certain sugars contained one class of impurity, and others another class, these impurities, when in contact, developing a dark compound. His remedy was to test the sugars before mixing, and take care only to mix those having a similar impurity. Was it not well to lift the workman up to the science, rather than to bring the science down to the workman?

THE WORK OF THE CITY AND GUILDS CENTRAL TECHNICAL COLLEGE.

By W. E. Ayrton, F.R.S.,

Dean and Professor of Applied Physics.

The author said that the Secretary had asked him to read a paper, but it was impossible for him to find time for writing a formal paper, and he had therefore been allowed to substitute instead a few minutes talk on the subject.

This Central Technical College is somewhat exceptional in its character. It is not a Government institution, nor is it supported by a municipality. It is, moreover, not a commercial enterprise, seeing that the certificate of registration especially forbids the participation of profits amongst its members, nor could it be regarded as a private concern. It is, I think we may say, the embodiment of the expression of the latter end of the 19th century—of the feeling of responsibility that exists amongst the Livery Companies of the City of London.

These Livery Companies—some of which are acting with the Society of Arts as our hosts in summoning this Congress—in days gone by constituted themselves the guardians of the welfare of the industries of our town, and secured the freedom of the artisan of the City to practice the mysteries of his craft. To-day it is not freedom, but knowledge, that the workman and the manufacturer require in order to achieve commercial success, and so some twenty-one of these companies joined together with the Corporation of the City in forming an institution with a long but expressive name—the City and Guilds of London Institute for the Advancement of Technical Education.

Now, the Central College of this Institute in Exhibition-road, was opened in 1884 "for providing instruction for advanced students in applied science" . . . "wherein no one should be received who did not show on examination that he had acquired in some of the existing science and art schools, or otherwise, a sufficient knowledge of science and art, so as to enable him to profit by the instruction." Consequently, from the very beginning, thirteen years ago, this Central College has had the enormous advantage of holding, yearly, an entrance examination, by means of which it has been able to weed out the incompetent from the candidates seeking admission; and, as the remuneration of no member of the College staff depends in the slightest degree upon the number of students in attendance, there is no fear that a point would be stretched to ease the entrance of a weak candidate.

The examination, in fact, has been intentionally kept fairly difficult for lads and girls of 16—the minimum age at which we admit them—it is about as hard to pass as the matriculation examination of the University of London. The subjects, of course, are somewhat different; our rules specifying that candidates must qualify in mathematics and mechanics, and pass in two of the three subjects of mechanical drawing, physics, and chemistry, whilst a knowledge of French and German facilitates the entrance of the candidate into the College. In the case of those who are competing for scholarships, there is a further test of their ability by their being compelled to pass practical examinations in physics, and in chemistry.

The fees are intentionally kept low, and produce a total amount of not half the current expenses—indeed, not a quarter, if interest on capital expenditure had to be taken into account—and there are also several entrance scholarships; so that a man, boy, or girl, being able to become a student of this College, depends almost entirely upon his or her ability and knowledge, and hardly at all upon the social or pecuniary position of the parents.

Every year about 70 candidates are in this way admitted, and the total number, therefore, of the first, second, and third year students in attendance at one time at the College is practically limited to 200. Now, this limitation of the members is of the utmost importance, because it enables a great deal of individual attention to be given to the students in their practical work, so that when they reach the third year of the course, they are capable of carrying on experimental investigations of real utility. With larger numbers, such individual attention would be impossible, and the object of the College, for higher technical education, would be absolutely defeated.

There is another advantage which this College possesses, and that is that the courses followed by the students who are qualifying to obtain a diploma in either the departments of civil or mechanical engineering, electrical or chemical engineering, are definite and prescribed, not merely recommended to be followed, but *required* to be followed. For the first year the courses are the same for all students. In the second year there is a certain amount of differentiation, and in the third year it is almost entire specialisation—that is to say, a third year student devotes himself or herself almost entirely to the study of those subjects which appertain to the particular profession which the student has elected to follow. In special cases, where the applicant has obtained a university degree at home or abroad, or by working in a factory, or otherwise, has had an exceptional opportunity of acquiring knowledge, admission is granted without the student being required to pass the entrance examination, and a special course may be followed differing from the regular courses prescribed for the diploma students. On the other hand, however, such a Special Student is not eligible for the diploma.

As I trust many of you will pay a visit to the College on Friday afternoon next, it is unnecessary for me to describe in detail the laboratories, the fittings in them, or the special apparatus which they contain. All that I hope you will see for yourselves. But perhaps you will allow me to say a brief word regarding the research work carried out in these laboratories of the Central Technical College.

At the opening of this College the late Lord Selborne stated that "in the several laboratories with which this College is provided new and increased facilities will be afforded for the prosecution of original research, having for its object the more thorough training of the students, and the elucidation of the theory of industrial processes," and as a supplement to the education which a student should receive at a college in the technical applications of science, it appears to me that the experience which he gains by carrying out a research is of great value in teaching him to think for himself, and acquire habits of self-reliance. Further, his having to adopt expedients for overcoming the experimental difficulties which are met with in all original researches, trains his ingenuity, and this is necessarily of great value to one who is about to become an engineer, and who may, therefore, be brought face to face with totally new problems in practical life.

The enumeration of all the investigations that have been undertaken by the students, assistants, and professors would weary you, so I will confine myself to the list of the researches carried out during the last session, 1895-96, which is given in the report issued at the end of 1896 by the Dean of the College. The list is a long one, for it contains the titles of some forty pieces of special work, with references to the different scientific societies in whose publications the accounts of the investigations may be found, and to the fact that in one case the society publishing the research awarded the students its premium for 1896.

The enthusiasm of the students in their laboratory work is most marked; the determination to come to a definite result, to carry the investigations to a final and successful issue, is most encouraging, and any investigation that has required absolutely continuous observation, and freedom from vibration, has never failed to secure the attendance of a group of students all night, during those hours which they would otherwise have spent in bed.

But the most striking fact in connection with the students, and one which tests the value of the education which they have received, is the success which attends their entry into industrial life. You are doubtless aware that a system of premium pupilage has, unfortunately, long existed in this country, and when a manufacturer can obtain the gratuitous services of an assistant and £100 in addition—well there is a considerable temptation for that firm not to offer a salary. Further, the growth of technical institutions has been very marked during the last few years, so that the number of engineering students who are now turned out year by year is very considerable. It might, therefore, have been expected that, year by year, those who complete their courses at the Central Technical College would experience greater and greater difficulty in securing berths at the completion of their course. And some years ago, when technical institutions were coming into existence at a more rapid rate than even one's most sanguine expectations could lead one to expect would be justified by the need for men to be trained in them, I must confess that I feared it might happen that students who should pass through our courses might find that they were armed with a scientific weapon that they had no means of using in industrial warfare.

But all these fears, I am happy to say, have turned out to be groundless. Every intelligent student—and I say it honestly, without boasting, and as a matter even of astonishment to myself—every intelligent student who goes through our complete diploma course secures a berth within a comparatively short time. Indeed, I may say even more than that. It has come about during the last two or three years that students are offered salaried posts before the completion of their College course, and before, therefore, they are able to leave the College to take up the duties which they are engaged to carry out; for example, some of the students who will complete their course with us next month—July—are already engaged for salaried employments. To-day, then, there is certainly as good, nay, even a better, chance for a man to obtain work speedily on completion of his course at the Central Technical College than there was years ago, when there was not a tenth of the number of institutions undertaking to give technical instruction.

So far, then, the condition of the College is entirely satisfactory, but there is one thing, however—not specially connected with this College as distinct from other London colleges—which does rather perturb me, and that is the want of co-ordination of education in our City. The power of giving instruction in London is great, the facilities for obtaining this instruction are increasing day by day, but there is absolutely no generalship, there is an absolute lack of any system of co-ordination. Why should not a student, who had decided to prepare himself for a particular profession, go from day to day, or better, perhaps, from week to week, to different colleges to receive instruction in the different branches of his training from experts who had devoted themselves to the different lines of thought and investigation? At the present time, every teacher of electrical engineering in London, for example, has, in his teaching, to go more or less through the whole range of the subject, and, therefore, but little advantage is taken of the special tastes and faculties that he possesses to develop along some one special line. The difference between the requirements of a tailor and a watchmaker is understood, that a professor of mathematics should not also be required to profess Latin and Greek is accepted, but little attention has been devoted to securing economical higher technical instruction in London. Each educational body apparently tries to imitate what its neighbour has found successful, instead of co-operating to secure still greater success. Every engineering student must learn many things, but there is no necessity that each student should learn everything at one place; even co-operative stores, where it is proposed to sell everything, have to be supplemented by auxiliary stores because the original project cannot be carried out in its entirety.

It has been objected that the distances between the different London colleges is too great for any effective co-operation, or co-ordination, in teaching to be carried into effect. But the objectors appear to forget that the students of any one London college not unfrequently come daily from Harrow, Lewisham, Wimbledon, &c., so that the homes of the students attending the same lecture are actually farther apart than are the different colleges to which they might go on different days, or during different weeks.

Much has been done during the last few years to improve education in London, but it will not be until there is co-ordination in the higher branches of the teaching that we shall have a system of instruction worthy of the greatest city in the world.

Dr. DUNN (Northern Polytechnic Institute) said he quite agreed, with Mr. Woodward, that it was very desirable indeed that all their plumbers and bricklayers and workmen of every description should have a thorough grounding in the principles of physics and mechanics and chemistry. But, while he considered that a general training in these sciences would be the best for trade students as for others, yet the experience to which Sir Philip Magnus had referred had shown that it was practically an impossibility to get trade students to attend such complete courses as Mr. Woodward suggested. In fact, after they had begun to work at their trades, they had not the time for it, and if they were to persuade these trade students to acquire even a little of the principles of the sciences underlying their various industries, they were more or less forced to a compromise, and they were driven to the course which Sir Philip Magnus mentioned in his paper. They were driven to devise for them special courses in which the principles of physics, and of mechanics, and of chemistry should be taught to them chiefly by illustrations drawn from their various trade practices. The connection which he wished to point out between the paper of Sir Philip Magnus and that of Mr. Wells was this: That whatever might be the case with regard to the artisan taught in these classes, it would be essential that the teacher should himself have a thorough training in mechanics, physics, and chemistry. There was one paragraph in Mr. Wells's paper in which he had spoken of the attempt which had been made to establish a system of dual control in technical classes, in which the practical part was taken by a workman who was a practical man himself and nothing more, and the theoretical teaching undertaken by a man who, whatever his theoretical qualities might be, was not a workman or a practical man. He had had some experience of that method of teaching, and had invariably found it unsatisfactory. The theorist never commanded the confidence of the artisan because he was not practically conversant with the trade, and, moreover, the two teachers were never able to work in complete sympathy and co-operation, if for no other reason than the simple fact that neither knew exactly what the other was doing. It was essential, therefore, in the present state of things, that there should be one teacher, not two of each technological class, and, inasmuch as only a man who had a fair knowledge of the principles of science could be expected to take from the material at his command precisely that which was requisite or which bore upon the needs of the artisan whom he had to teach, it would be essential that the teachers in our technological schools should undergo some course of continuous and serious training, such as that which had been so admirably sketched by Mr. Wells. If we could by the adoption of some such system as that, look forward to the certainty of having teachers of technological classes equipped in that way, then we could afford to wait for that time. Such a system was an eminently workable one, one that could be put into practice everywhere, and one which, in a very few years, would bring about a revolution in the ordinary qualifications of the technological teacher.

Professor SILVANUS THOMPSON said that the point which Sir Philip Magnus had raised, that it might have been thought that ordinary instruction in mechanics, physics, and chemistry would be the best preliminary instruction for artisans engaged in trade processes, whereas experience had shown it was not so, was a very interesting point to him, inasmuch as that had also been their experience at Finsbury College to a considerable extent. He was speaking now of evening classes for trade students, and the reason was substantially that which Dr. Dunn had urged—that the students who went to these trade classes could not be induced to go outside what they considered to be the training which was obvious for them—they could not get them to attend classes which were known by these abstract names. A plumbing student, for example, could not be got, as a general rule, to attend classes on geometrical drawing, taught by a drawing-master, and for this simple reason—that the geometrical drawing teachers taught geometrical drawing not of the plumbing, but of scores of different trades, and did not understand one of those trades, or why the plumber wanted to know geometrical drawing at all. The plumber, therefore, had no confidence in him, because the teacher could not teach him that particular kind of geometrical drawing which he wanted. Drawing was an essential in how many different crafts? Practically in every one. The engineering fitter, the carpenter, the plumber, the metal worker, the cabinet maker, all these needed a knowledge of drawing, and yet it would be absolutely useless to put all these men together in one class, under one teacher, because the teacher would not know what to draw. You must have the cabinet maker taught drawing by a man of his own craft, the plumber taught by a plumber, and so on, or else they would not secure the confidence of the students, and they would not believe that their classes were of a thoroughly practical and useful character. The admirable paper which Mr. Sidney Wells had given them upon the training of technical teachers he wished to most heartily endorse. He had made experiments in the same way, and had found that it required a special kind of young workman to train into the future teacher. And, lastly, he wished to strongly and cordially emphasise the weighty words of Professor Ayrton upon the want of co-ordination in their educational institutions, as between the highest and lowest. He only wished there were more coordination between the Technical College at Finsbury and the higher Central Technical College in Exhibition-road. But the difficulty of co-ordination in London was mainly geographical. It was almost impossible to send a student from one end of London to the other. He had tried to establish something of the kind, but the geographical difficulties were too great. The library of the Central College was in Exhibition-road, and they could not expect a student from Finsbury, who wished to consult a book in that library, to do so, when it would involve a journey of half-a-day. However, geographical co-ordination was one thing, but coordination in instruction was quite another, and that was where real need for reform lay. He could point to two institutions having, practically, on paper, the same programme, but whereas in the one case lads of 13 and 14 years of age were being taught, the other was giving the highest and most specialised training to young men who had already passed a tough matriculation. Yet, on paper, the programmes were equal. There was an obvious want of coordination when two institutions having such widely different aims, and so totally differently equipped, should appear, on paper, to be giving exactly equal instruction.

Mr. A. PARK, J.P. (Ashton-under-Lyne), wished to express his gratitude to Mr. Wells for the excellent paper he had read. Representing one of the largest technical schools in one of the manufacturing towns of the North, they had experienced the difficulty, having a school which was attended by over a thousand students, that Mr. Wells had mentioned, in finding teachers who should give a practical interest to the subject they taught, and yet have a thorough knowledge of it. They were able to secure a class for plumbing, and to get it attended by about 20 students, but it did not succeed, largely because for a teacher they had an intelligent man who had little knowledge at all of the principles of teaching. Another point alluded to by Mr. Wells was of very great moment. How were they to get a practical artisan, if he were busily engaged from six o'clock in the morning to six o'clock at night, in these small provincial towns, where they were anxious to promote the local industries, how were they to get these men so equipped with the faculty of teaching as to make their teaching successful? He hoped that city guilds and other companies, who had shown such interest in the whole subject, would give pecuniary facilities and help in that direction. In Ashton-under-Lyne they rated the borough a 1d. in the £ for the support of technical education, but hitherto they had found a difficulty in regard to the teaching so serious, that they had been almost compelled to restrict their teaching, in that large and otherwise successful school, to the training and education of those that attended it for the purpose of learning the principles of science that underlay their different local industries. He hoped that one result of the Congress would be to stimulate those who were engaged in this work in small provincial towns, where they had a comparatively small constituency to draw upon, and where the opportunities and facilities for providing material in the way of teaching capacity, to carry on the work of technical trade subjects, were almost insuperable.

Dr. W. GARNETT thought they were all agreed that it was essential, if they were to attract artisans to their classes, that the teachers should be thoroughly acquainted with the practical details of the trades to which the artisans belonged; but there were two difficulties, which they encountered at the start, with which they had to contend. Both those difficulties had been already alluded to, but he wished to accentuate them. The first was the long hours during which the artisan had to work in the shops. The first "quarter"—the hours before breakfast—formed the real difficulty in the organisation of technical instruction, for the man who had to be in the workshop at six o'clock in the morning could scarcely be expected to efficiently devote his evenings to class work; and if he gave up his practical work, he must give it up entirely. He could not generally succeed in getting shorter hours, and the workman who gave up his work entirely was very much like the teacher who, after devoting himself for five or six years to educational organisation, instead of teaching, attempted to solve a difficult differential equation on the blackboard before a class without having seen it beforehand. The second difficulty was the time that was required to produce a good teacher. In the training of a teacher, as in the preparation and manufacture of steel, the "soaking pit" had a very important function to fulfil. Without it, the steel ingot, when the pinch came, was liable to burst, and scatter death and destruction all around, or else it had to be re-heated for each successive operation, involving a great waste of fuel, which, educationally interpreted, meant that the young or imperfectly-trained teacher had to cram up his lesson first before he met his particular class. Those two difficulties meant that a considerable time must elapse before they could secure a class of practically-trained teachers who had also been trained to teach, and in the meantime the best temporary solution at their command was that of dual control. As a rule, the system of dual control would not work, but he believed there were conditions under which it could be made to work fairly satisfactorily as a stop-gap. When he first began to teach technology to plumbers, he used to get the practical teacher to come to his class, and to lecture to him as well as to the other students, and then he used to get the plumber to tell him how far he had made himself intelligible to the class, and to suggest to him the difficulties which the students met with, and how to make his (Professor Garnett's) teaching more applicable to them, so that they had the theoretical teacher, so to speak, and the practical teacher together at the same time. He had felt the same difficulty in dealing with those mechanical trades which depended upon artistic training, and recently, in the case of a class of plasterers in the West of London, when it was wanted to introduce a modelling master amongst the plastering apprentices, and they felt that a modelling master from the school of art would soon find himself out of touch with those young men, they arranged that the practical teacher of plastering should almost always be present at the modelling class, when the modelling master was dealing with the apprentices, so that he might give the necessary practical turn to the instruction of the modelling master, and also that, by his presence, he might inspire that confidence in the young apprentices without which they very soon lost interest in the teaching of any teacher, however well trained that teacher might be.

Mr. C. T. MILLIS (the Borough Polytechnic) thought it was of the highest importance that the function of the workshop, in regard to trade education, should be fully recognised. The workshop should be used for illustrating the principles which were learned in the class room, and the workshop should be so fully equipped that the students might be taught to become good "all round" workmen. The unfortunate part of technical trade education in the present day was the difficulty of getting the workman to realise that there was something more than a part of a trade to learn. He knew that in ordinary works it was the custom, owing to the almost minute sub-division of labour in some industries, for the workman to feel that only one little branch of their trade entitled them to be recognised as a workman in that particular trade. He had heard in a London Conference the representative of a trade society ask for three teachers to be appointed by the Technical Education Board, in order to provide instruction for what he considered a portion of a particular trade—for one division of the industry itself. That was one of the difficulties they had to deal with, and one that was increasing every day. And so teachers should be chosen with the view of their training the workmen studying under them to become better all-round workmen than they were at the present time. Another point upon which he wished to speak was that alluded to by Sir Philip Magnus in connection with the teaching of elementary science. After very considerable experience of trade students in London, he could confirm what Sir Philip had said, for he had found it a practical impossibility to get the ordinary workman of the rank-and-file to attend the Science and Art Department classes in geometry, mechanics, machine-drawing, and chemistry. He had been accused on many occasions of being an enemy of the Science and Art Department classes in London, but he was not, and they must remember that, although such classes had been attended by artisan students, they had been attended by the very pick of artisan students. It was not his intention or desire to say one word against those classes, but they must remember that there was something absolutely necessary in the teaching of artisan students at the present time, and one important step had been taken by the City and Guilds of London Institute in introducing syllabuses as guides for the preliminary scientific instruction of students attending the trade classes. Much as he agreed with the paper of Mr. Wells on many points, it did not touch, he thought, upon one point which was at the root of the difficulty of getting good trade-class teachers. There were two causes of that difficulty—one the want of the necessary time in order that the teachers might prepare themselves for teaching, and the other was the want of recognition which they received, as well as inadequate remuneration.

Professor CHATTERTON, as one of the earlier students at the Finsbury Technical College and subsequently at the Central Technical College, South Kensington, wished to add his testimony to the remarks of Professor Ayrton respecting the excellence of the training which the students had received there. He had been through the complete course of instruction for civil and mechanical engineers at both Institutions and so was in a position to speak of the excellence of the methods of imparting instruction to the students. He was happy to say that he was fairly well acquainted with the careers of all his fellow students, and it was a fact, which he could vouch for, that they were all doing very well, though engaged in the most varied branches of technical work. This was, he thought, perhaps the most valuable proof he could offer of the efficiency of the educational work which was now being carried on under the direction of Professor Ayrton and his colleagues.

Professor J. VIRIAMU JONES, F.R.S. (principal, University College, Cardiff), thought there was a danger of their committing themselves to an educational heresy, in the interests, not of the better education of the working man, but in the interests of the attractiveness of the classes. Now, there were two distinct and definite questions. It was a surprise to him, for instance, to hear Professor Silvanus Thompson maintain that all the freehand drawing to be learnt by a plumber should be taught by a plumber, who was a man engaged in the trade, but who, if he was going to teach all the other trades as well, would be a Jack-of-all-trades. With respect to physics, would it not be absurd that plumbers who went to the College at Finsbury to learn physics should have physics taught by a plumber, when they might enjoy the opportunity of hearing lectures upon the very same science from no less an authority than Professor Thompson himself? He hoped they would not commit themselves to the theory that their artisans would not in the course of time find the best instruction, in much of the science bearing upon their trade, the most attractive. He hoped and believed that the good sense of our artisans would make that view prevail. And they must not forget that we were now in a period of transition, and in a period of transition to take what was not the best educational principle as our guiding principle might be expedient if they only knew what they were doing, and if they realised that the highest educational aim was not theirs at the moment. The problem of how to make a man into a good artisan and the problem of how to make an artisan learn were quite different. We in England were endeavouring to solve, through our educational system, the problem of how to make a man a good artisan. Many of the remarks he had listened to in that discussion had seemed to indicate that what was mainly present was the mere temporary problem of how they were to persuade artisans—a great many of whom had not had the advantage of a preliminary training in the elementary educational schools—to go to classes as an adult artisan in order to learn the science bearing upon his trade. He did hope that they would not, in this period of transition, commit themselves to the idea that the artisans of England were not going to take advantage, in respect to the science bearing upon their trades, of the very best teaching that could be supplied to them. He was convinced that it would not be long before they felt that to be taught by a specialist in mechanics, physics, chemistry, or drawing, was a far better thing for them than that they should be taught by one of themselves who might have learned a little of those subjects. He wished to conclude by giving a high testimony to the work of the students at the Central College, for he had seen them at work, and the energy with which they threw themselves into their studies and investigations bore out all that Professor Ayston had said of them.

Mr. J. H. REYNOLDS (director, Municipal Technical School, Manchester) said there was a note in the remarks of Professor Ayrton which deserved a wider application than he had given to it—that of co-ordination. Was it not time that the Science and Art Department and the City and Guilds of London Institute took into consideration the question of co-ordination? The want of co-ordination between those two departments, who, by their programmes, were doing so much to control and direct the whole policy of technical education in this country, was painfully evident to anyone concerned in the subject.

Classes were established in connection with the Science and Art Department, and also in connection with those of the City and Guilds of London Institute, and those classes were continually overlapping each other to the serious detriment of the work in which they were engaged, and to the serious waste of time of the students. He thought the time had arrived when those important institutions should consider whether it was not possible to arrange a programme of instruction which would do away with the present wasteful overlapping. The Technical Instruction Act said that it was not legal to teach a trade in a school. That was a portion of the Act which remained a dead letter in most localities, but it was on the plane of a good deal of the armchair legislation from which the country suffered in reference to education, as it was arranged not with reference to the needs of the subject, but on the lines of the bureaucratic experience of those who knew very little of what was demanded by the interests of technical education in this country. He thought the time had come when large centres of industry should be permitted to arrange their own schemes of technical instruction. They knew what they wanted much better than any council or body sitting in London, which must necessarily be out of touch with the actual requirements and interests of those districts. As to teaching, his experience had been that some of their most valuable teachers had been men who had had hardly any college training whatever, but they had the practical knowledge, and the zeal, and the power of imparting knowledge, which were essential to the true technical teacher. The plumber had been very much in evidence during their discussion that morning, but it was of no use to put him under a teacher, however well trained in science, who had not a practical knowledge of the craft. He should be under the direction of one responsible teacher, who knew the application of science and art to the trade of the plumber, and could therefore give to an artisan an intelligent knowledge of the principles of the science which underlay his business. The workman would take that knowledge gladly from the man in whom he had confidence, as a man who really understood the art and practice of the plumber. And what applied to the plumber applied equally to the carpenter, to the engineer, and to the textile student. In Manchester they found that if they wanted a carpenter to take up the subject of geometry they must perforce put him in the hands of a man who understood the application of geometry to the art of the carpenter and the joiner. He would not take his instruction from the engineering instructor. And so on with the textile trade. If they wished for the attendance of those who desired to understand textile weaving, and the mechanism by which it was accomplished, they must get the instructions given by a man who had devoted himself to the mechanism of weaving, and who, if he dealt with the subject of applied mechanics, would take his illustrations from the intricate machinery in connection with which the student was engaged. Only in that way could they get the student interested in the practice of his own craft. That did not necessarily imply that the head instructor in weaving or in like subjects was a man who would do all the teaching in all branches of the subject, but if they wanted to have the work thoroughly well done they must put it in the hands of one who had a general knowledge of the whole of the matters to be dealt with, and he must be helped by men who had devoted themselves to mechanics or other sciences connected with weaving, or whatever the subject might be. But they could not do that, and work with the Science and Art Department and the City and Guilds of London Institute too, and the time had come when the grants given by the Science and Art Department should not, as now, be given for separate subjects, but placed in the hands of responsible bodies, such as the municipalities, who would work in the best interests of education. The gentlemen who composed these bodies might be trusted to do their work well—they dared not do it ill—and thus, instead of diffusing their efforts over a variety of science subjects, in order to earn the grants of the Science and Art Department, they would restrict their teaching to those subjects which were of most importance to the industries of their district. But the root of the difficulty of successful technical instruction was not whether they were to teach science to the artisan so much as of preparing him in the elementary schools of this country, by means of a sound general training, continued until 14 years of age at least, to take the subsequent instruction necessary to the artisan, no matter in what industry he might be engaged. The student who came to the technical school at 14 years of age ought to know enough of physics, elementary chemistry, and geometry to take the special instruction they were prepared to give him. They were wasting most valuable time throughout the various technical schools of this country in giving the most elementary instruction in ordinary school subjects, instead of training the artisan. Take plumbers, for example. There were scores of men who could not make the simplest calculation in arithmetic, and when they came to the examination of the City and Guilds of London Institute they would find instance after instance where the student had not answered a single question. It was not because the plumber, in many instances, did not know his subject, but simply because he had not the faculty of writing down in an intelligent way that which he really and truly knew. They had had the same experience in Manchester in regard to instruction for shoeing smiths. The examinations in connection with it had been of the greatest possible good to a class of men who had hitherto not come within the purview of technical instruction, but they dared not ask these men to answer by means of a written paper. They would be utterly incapable of doing it, and consequently nothing but a *viva voce* examination could test the knowledge which these men really possessed.

The whole system of our methods and means of technical instruction needed revision, and should be placed in the hands of the responsible bodies in the various districts, to whom is entrusted the spending of the public money, and who had the power and the resources needful for the effective organisation of technical instruction. If that were done, they would make strides in imparting technical instruction of which they now little dreamed, but so long as they had regulations such as those which appeared in the late Departmental Report on the Distribution of Science and Art Grants he utterly failed to see how they could compass what they had in view—the imparting of a sound technical knowledge to the people throughout the length and breath of this country.

The Right Hon. A. J. MUNDELLA, M.P., said he felt impelled to say a word or two to accentuate what had fallen from Mr. Reynolds. He had demanded, very rightly, that there should be less overlapping, but what a deplorable picture he had given them! The overlapping was really this—that the science and art teacher was required to be an elementary teacher in order to furnish the working men with the necessary knowledge to enable him to take advantage of the teaching which he came to receive. The whole of the root of the mischief of which he complained was what was very common in Lancashire—the half-time system, and the low standard of our elementary education. The first thing to be done, before they could expect intelligent working men to receive instruction bearing upon their industry, was that they should be properly taught, and the ground prepared, in the elementary school, and that the science teacher should not have to take the place of the elementary teacher, and bring about that overlapping of the elementary teacher's work, which was much more common than the overlapping by the elementary teacher taking the work of the secondary teacher. Our standard was altogether too low. Mr. Reynolds spoke of a number of plumbers coming into the Manchester school who had never held a drawing pencil in their hands. Those men ought to have been prepared in the elementary school, and drawing ought to be taught in every elementary school. The moral which he wished to draw from that was to urge upon Parliament the necessity of raising the attendance at schools to the same length of period and to the same age as that which prevailed in other countries, where technical education was carried on to a greater degree. Until they did that they were calling upon the technical teacher to make bricks without straw. Herr von Diefeubach would tell them that 14 was the age to which they remained in the elementary schools in Wurtemburg. In Switzerland it was raised to 16 years, and we in England still clung to our miserable half-time system. What could we expect from a system in which children began half-time at eleven and left school at thirteen? He had been in the rural districts lately, and found that the fourth was the prevailing standard. We had science and art schools and polytechnics abounding all over the country, but those who attended them were quite unprepared to take advantage of the instruction given. They must first raise the age of elementary education, and then he was sure that Sir John Donnelly would be very glad indeed, with the rest of the Science and Art Department, to vest more power and money in local hands, and to place higher education under local control. And then they would be able to prevent overlapping. But don't let them part with the little higher education which they had to give to the masses of the country—the little higher education they got in our best elementary schools until such time as they had raised the whole standard of elementary education in the country, and prepared the masses to take advantage of those institutions which they were now, for the first time, bringing to their door.

The CHAIRMAN, in bringing the discussion to a close, thought he should say a word or two, otherwise it might be considered that they had not really appreciated the value of the papers which have been read to them. It was impossible from the first to have anticipated the difficulties that technical education would meet with, and they were now striving to solve those difficulties. Sir Philip Magnus had referred to those words of the Technical Instruction Act which forbade the teaching of the practice of any trade or profession. But the Act would never have been passed had those words not been included in the definition, and he thought all the difficulty was really met when they laid emphasis on the word "practice." That is to say, they might teach how a thing was to be done, but they must not carry the teaching so far as to give that rapidity and dexterity of manipulative skill which was required for the craftsman or journeyman, and if they regarded the words of the Act in that way they would find that there was really not much difficulty in working the Act satisfactorily, and, as a matter of fact, he did not think that difficulty had been discovered. There was one point with regard to the teaching of students upon which Professor Jones had admirably touched. They were rather apt not to sufficiently distinguish between what the students wanted and what was good for the students. It might be necessary possibly at first to have a technical teacher to try to teach drawing, as, for instance, a cabinet-maker to teach cabinet-makers, but he was glad to say he was not taught drawing by an engineer. Professor Ayrton's remarks on co-ordination rather dwelt upon the circulation of the students than the co-ordination of the different institutions in London, but the difficulty raised by the size and population of London should be taken into account. He hoped he might tender, on behalf of the Congress, their thanks for the papers which had been read to them.

WEDNESDAY AFTERNOON, 16TH JUNE.

SECTION A.

The Right Hon. A. J. MUNDELLA, M.P., in the chair.

The CHAIRMAN, in introducing Herr von Diefenbach, of Stuttgart, said that those of them who had read the report of the recent Committee, published by the Irish Members of the House of Commons some time last Session, would have read with the greatest interest the report of their Commissioner, who had visited Wurtemberg. Forty years ago it was a poor country, almost wholly agricultural, and there was great lack of employment, especially in the winter. Since then the Kingdom of Wurtemberg set up a Commission to give industrial instruction to the people. Herr von Diefenbach was a member of that Commission, and so had a practical acquaintance with the whole question. The report given by the Commissioner of the Irish Committee was to the effect that he found no part of the Continent of Europe more prosperous than Wurtemberg, and that he left the country with the assurance and the highest confidence that there was not a pauper in the Kingdom. They might, therefore, look forward with interest to Herr von Diefenbach's paper.

TECHNISCHE ERZIEHUNG IN WÜRTTEMBERG.

By J. v. DIEFENBACH.

Württemberg im Süden von Deutschland hat nur zwei Millionen Einwohner und 19500 kilometer Land; es ist vom Neckar und der Donau durchflossen, an der Ostseite des Schwarz—waldes gelegen zwischen Baden und Bayern, im Süden vom Bodensee begrenzt. Das Land ist von verschiedenen Gebirgen durchzogen, grossentheils fruchtbar; die Bevölkerung lebte bis in die 43 Jahre von Ackerbau, Viehzucht und Weinbau; ein wohl entwickeltes Kleingewerbe sorgte für die Verarbeitung der heimischen Rohproducte und das Land bildete ein nahezu für sich abgeschlossenes Wirthschaftsgebiet; bloss handgewobene Leinen- und Wollstoffe und Leder fanden ihren Weg nach den benachbarten Baden, Bayern und der Schweiz.

Von mineralischen Schätzen birgt das Land reiche Eisenerze, grosse Steinsalzlager und Kalksteinberge, deren Verwendbarkeit zur Herstellung von vorzüglichem Portlandcement erst in den letzten 20 Jahren erkannt worden ist.

Steinkohlen fehlen ganz, reiche Wälder und Wasser-Kräfte sind vorhanden; der Neckar ist die einzige Wasserstrasse für Schiffahrt.

Die Bevölkerung ist arbeitsam und intelligent, ⅓ Katholich und ⅔ Protestantisch; sie hat sich so vermehrt, dass schon seit Anfang des Jahrhunderts eine grosse Auswanderung nach den Vereinigten. Staaten von America eingetreten ist und dass es noch jetzt wenige Familien im Lande gibt, die nicht Verwandte in America, meist in Pensylvanien, haben. Seit Jahrhunderten besass das Land eine Verfassung, die an die Seite der Regierung zwei Kammern setzte; es besass unter einem weisen Fürstenhause eine vaeterliche Regierung, die vielleicht in dem Volke zu sehr das Bewusstsein erweckt hat, dass die Regierung für Alle zu sorgen und für alle Eventualitäten ein zutreten habe, ganz im Gegensatze zu den Auschauungen des britischen Volkes mit dem ausgesprochenen Gefühle der Selbst verantwortlichkeit und Selbstregierung.

Zunächs einige *historische Mittheilungen* über die *Entwicklung* des *Schulwesens in* Württemberg. Die Regierung gründete die *Universität Tübingen* im Jahre, 1477, gleich mit 4 Facultäten einer theologischen, juristichen, medizinischen und philosophischen oder artisten facultät. *Eigentliche Volksschulen* gab es im 15-ten Jahrhundert im Lande noch nicht, wohl aber zahlreiche *Lateinschulen* die meist aus den *Klöstern* hervorgingen; im Jahre 1387, hatte man schon in Stuttgart, der Hauptstatt, einen öffentlichen Schulmeister.

Herzog Christof v. *Württemberg* gab als erster deutscher Fürst im Jahre 1559 dem Lande eine neue *Kirchenordnung*, in der der Begriff dem *Volksschule* klar erfasst war und der die *Latein-* und *Particularschulen* eingehend ordnete; es enstanden 12 *Klosterschulen*, die zum Besuche der Universität vorbereiten und von denen heute noch 4 bestehen, an das sich das bekannte theolog. *Stift* in Tübingen anschliesst.

Einen weiteren gewaltigen Impuls gab dem Unterrichtswesen des Landes die im Jahre 1781 von *Herzog Karl* errichtete *Karlsschule*, nach dem Ausspruche des Universitäts Kanzlers Rumelin, "*der erste Strahl des neuen in Europa aufgegangenen Lichtes*"—Sie war die *Zweite Universität* des kleinen Landes, gieng aber mit dem Tode des Fürsten nach 14 jaehrigem Bestehen wieder ein. Die berühmtesten Karlsschüler waren der Dichter *Schiller* und der Geologe *Cuvier* und Andere. Kaum eine der vielen Anregungen, welche die Karlsschule gegeben, ist verloren gegangen und fast eine jede in ihrem Kreise der Kern und Mittelpunkt für *neue Schöpfungen* geworden.

Aus dem *Gymnasium* in Stuttgart, das nur die *alten* Sprachen pflegte hatte sich im Jahre 1796 eine *realistische* Abtheilung herausgebildet und aus dieser entstand im Jahre 1818 die *erste Realschule* des Landes; es bestehen jetzt 14 grössere, und 66 kleinere; im Ganzen 80 *Realschulen* im Lande.

Aus der Stuttgarter Realschule entwickelte sich im Jahre 1832 die *Gewerbeschule,* als eine für sich bestehende Anstalt; sie wurde im Jahre 1840 zur *Polytechnischen Schule* umgewandelt. Von ihr zweigte sich im Jahre 1845 zur Ausbildung von Bauhandwerkern und niederen Architekten die *Kgl. Baugewerkeschule* ab.

Seit 1853 kamen dazu die *Gewerblichen Fortbildungsschulen*; mehr machte sich auch die Fürsorge für die Fortbildung des *weiblichen Geschlechtes* geltend; man errichtete *weibliche Fortbildungsschulen* und *Frauenarbeitsschulen.* Damit ist in Kürze die Entwicklung des Schulwesens dargelegt; und es soll nun einiges Organisatorisches und Statistisches folgen.

Die technische Hochschule in Stuttgart gliedert sich in 6 Fachschulen, für Architektur, Bauingenieurwesen, Maschinenbau, chemische Technik, Mathematik und Naturwissenschaften und für allgemein bildende Fächer. Seit ein Paar Jahren ist der Anstalt eine *besondere Abtheilung* für *Electrotechnik,* der *ersten* in *Deutschland* mit umfassendem Laboratorium zugelegt worden. Zahl der Hauptlehrer 21, Hilfslehrer 25, Schülerzahl c. 650. 2/3 von Württbg. 1/3 Ausländer. Aufnahme-alter in der Regel 18 Jahre. Studienzeit 3—4 Jahre. Jahresaufwand, 330000 Mk. eigene Einnahmen 58000 Mk., so dass ein Jahres Zuschuss der Regierung von 270000 Mark erforderlich ist.

Die *Kunstgewerbeschule* in *Stuttgart* soll für die verschiedenen Zweige der *Kunstindustrie* solche Kräfte heranbilden, die in ihrem Fache einen höheren Grad kuenstlerischer Ausbildung erstreben und besonders auch der Ausbildung der *gewerblichen Zeichenlehrer* dienen; Ateliers für Architekten, Bildhauer, Modelleure, Ciseleure, Decorationsmaler.

10 Hauptlehrer. Schüler Zahl *Winter* 120—130; *Sommer* 70—80. Jährlicher Staatsaufwand 50,000 Mk.

Die *Baugewerkeschule* zerfällt in eine Vorclasse, 2 mathematisch naturwissenschaftliche. Classen und 3 *Fachschulen* und zwar:—

(*a*) für Bauhandwerker—niedere -hoch- und Wasserbautechniker.

(*b*) für Geometer und Kulturtechniker.

(*c*) für Maschinentechniker und Electrotechniker.

Die Anstalt zaehlte im Jahre 94/95.
im Winter 20 Abtheilungen.
,, Somer 10 ,,
mit 23 Hauptlehrern und 13 Hilfslehrern.
Schülerzahl, Winter c. 720.
,, Somer c. 470.
Jährlicher Staatszuschuss 125,000 Mk.

Unter den Schülern sind in der Regel 25 °/₀ Ausländer.

Für diejenigen, welche die 2 letzt genannten Austalten kennen lernen wollen, sei bemerkt, dass daselbst je eine *permanente Ausstellung* von *Schülerarbeiten* aus *früheren Jahren* vorhanden, die rasch ein Bild über die Leistungen und Fortschritte dieser Schulen geben.

Mitte der 50 Jahre mit der Entwicklung der *modernen Gewerbe* im Lande veranlasste mein langjähriger früherer Chef, Dr. von Steinbeis, die Gruendung der *gewerblichen Fortbildungsschulen.*

N.B.—Zu eingehender Information: "über die gewerbliche Erziehung in Württemberg von Carl Genauck, Ingenieur und Professor. Verlag: A. Schöpfer in Reichenberg, Mähren —ferner:

Statistik des Unterrichts und Erziehungswesens im Königreich Württemberg. Veroeffentlicht im Ministerium des Kirchen und Schulwesens erscheint alljährlich, Verlag W. Köhlhamer, Stuttgart.

Sie sollen der gewerblichen Jugend beiderlei Geschlechts über 14 Jahre in einem freiwillig und unter Bezahlung eines Schulgeldes besuchten Unterricht, die zu einer rationellen Ausübung der practischen Thätigkeit in Gewerbe, Handel und Haushalt nöthigen theoretischen, beziehungsweise artistische Ausbildung ermöglichen.

Im Jahre 1894-95 bestanden gewerbl. Fortbildungsschulen in 223 WürttembergOrten, mit einer Einwohnerzahl von c. 867000 Seelen—28 dieser Schulen haben Sonntags, Abends und auch Tages zeichenunterricht; 100 nur Sonntags und Abendunterricht. Lehrerzahl in allen Anstalten zusamen 1146; Schülerzahl circa 24000, darunter 6000 weibliche, welche grösstentheils die Frauenarbeitschulen besuchen.

Die besuchtesten Unterrichtsfächer sind zur Zeit. Freihand zeichnen mit 14300 Schülern.

Rechnen	,,	15000
Deutsche Sprache	,,	9700
techn. Zeichnen	,,	7000
geometr. ,,	,,	5000
Buchführung	,,	3600

Die besuchtesten Fortbildungsschulen des Landes sind:

Stuttgart:	149	Lehrer,	2000	Schüler	und Schülerinnen.
Heilbronn	40	,,	700	,,	,,
Esslingen	38	,,	700	,,	,,
Ulm	38	,,	680	,,	,,

Die Gemeinden haben die *Schullocale* zu stellen, welche viefach auch noch gleichzeitig von anderen Schulanstalten bernützt werden.

Die *Kosten der Lehrergehalte* werden vom *Staate und den Gemeinden, je zur Hälfte*, bestritten.

Der *Gesammtstaatsaufwand* für diese Schulen, welche von Inspektoren des Staates regelmässig inspicirt werden, beträgt jährlich. 204000 Mark.

Für unsere *Arbeiterclassen* bildet die *gewerbliche Fortbildungsschule* desshalb eine so wichtige Bildungsgelegenheit, weil sie auch dem jungen Manne ganz unbemittelter Familien Gelegenheit bietet, während seiner Lehrjahre d. h. vom 15ten Jahre an, wo er schon einen Theil seines Lebensunterhaltes verdient, sich weitere für sein Fortkommen und Aufsteigen werthvolle Kenntnisse und Fertigkeiten anzueignen—Eine der Schwierigkeiten für den Besuch dieser Anstalten bestand früher in der landesübligen *langen Arbeitszeit* — 11 - 12 Stunden per Tag; die Arbeitszeit ist aber nun auch in Deutschland viel kürzer geworden und das kommt dem Besuche der Schule sehr zu gut.

Unsere *Fortbildungsschulen* sind keineswegs nach einer Schablone eingerichtet; sie richten sich nach örtlichen Verhältnissen und Bedürfnissen; Z. B. sind an Orten wo *Kunstgewerbebetriebe*:—Stuttgart, Heilbronn und Gmünd — besonders befähigte Lehrer und Classen für artistisches Zeichnen, Modelliren, Ciseliren, und Graviren angestellt; an anderen Orten, wo zahlreiche *mechanische* Werkstätten und Maschinenbauanstalten vorhanden wird dem Maschinenzeichnen besondere Aufmerksamkeit geschenkt; an anderen Orten wird das Bau- und Möbelzeichnen besonders gepflegt.

Von grösster Wichtigkeit ist die Gewinnung tüchtiger *praktischer Lehrer* für diese Anstalten; man sucht wo möglich solche Kräfte zu gewinnen welche als Werkmeister in einem Gewerbe noch thätig oder thätig gewesen sind. In groesseren Städten ist das weniger schwierig als an kleineren Orten. Die Regierung ist seit vielen Jahren bemüht Gewerbetreibende, welche besondere Befähigung zeigen, zu *tüchtigen Lehrern* für Fortbildungsschulen dadurch auszubilden, dass sie solchen Unterstützungen zum Besuche höherer technischer Lehranstalten verleiht.

Von besonderem Erfolge war die hausgewerbliche Ausbildung von *Schülerinnen* durch Gründung der *Frauenarbeiteschule* in *Reutlingen*, die sich aus den kleinsten Anfängen heraus entwickelt hat; diese Anstalt ist alljährlich von cir. 400 Mädchen besucht; sie unterrichtet dieselben in allen *weiblichen Handarbeiten* und bildet nun hauptsächlich *Arbeitslehrerinnen* aus, die Anstellungen in den fernsten Ländern gefunden, und zur Gründung zahlreicher ähnlicher Anstalten im Auslande geführt haben.

Um den gewerblichen Fortbildungsschulen für beide Geschlechter stets eine praktische Richtung zu sichern ist deren Leitung ausser dem Schulvorstande einem localen *Gewerbeslchurathe* unterstellt, bei dessen Wahl man die Herbeiziehung hervorragender Gewerbetreibender stets im Auge hat.

Unsere Fortbildungsschulen sind noch weiterer Ausbildung fähig; wir sind darin aber noch nicht so weitgegangen wie unsere Nachbarn in der Schweiz und in Oestreich wo eigentliche *Lehrwerkstätten* für verschiedene Gewerbe, wie Schreinerei, Metallarbeiten, Uhrenfabrication errichtet worden sind, die die eigentliche *Gewerbelehre* zu ersetzen suchen. Es ist aber auch in dieser Richtung bei uns eine Bewegung in Gange; bis jetzt sind nur 2 *Spezial schulen für Weberei, Strickerei, Färberei* und *Appretur* im Lande eingerichtet; da werden nur solche Schüler aufgenommen, welche schon praktische Weber sind, oder Leute die solche Geschäfte betreiben wollen, bei denen die Kenntniss der Webereitechnik von besonderem Werthe ist—; bei unseren Webschulen wurden die Gebäude von den Städten erstellt, während der *Betrieb* in den *Händen einer Cooperativ* - association ruht, der die Industriellen der Gegend angehören.

Die *Verbindlichkeit zum Besuche der Volksschule* erstreckt sich in Württemberg auf die Kinder aller Staatsangehörigen, soweit dieselben nicht eine höhere Schule besuchen oder Privat unterricht erhalten. Die *Schulpflichtigkeit* beginnt bei jedem Kinde im 7ten und endigt im 14ten Lebensjahre. Nach Verlassen der Volksschule besteht für alle die Verpflichtung zum Besuche einer *Sonntags- oder Abend schule* bis zum 18. Lebensjahre.

Die Verbindlichkeit für *Errichtung und Unterhaltung der Volksschulen* liegt auf den Gemeinden.

Die Schulzeit beträgt 26 Wochenstunden; davon entfällt 1/3 auf Religionsunterricht

3/7 auf die Sprache
2/7 auf Rechnen und Raumlehre
2/7 auf Realien und Singen.

Auf einen Lehrer rechnet man 90 Kinder—; die Ausbildung der Lehrer erfolgt in 4 evangelischen und 2 katholischen Schullehrerseminarien.

Die *Fertigkeit* des *Lesens und Schreibens* bilden die unerlässlichste Voraussetzung aller höheren Bildung; die gesetzliche Schulpflichtigkeit aller Kinder besteht heute in allen deutschen Ländern, in Württemberg schon seit mehr als 3 *Jahrhunderten*—In Württemberg kann Jedermann mindestens *lesen und schreiben*—*Rechnen* wird allgemein gepflegt, fast in jeder Schule finden sich tüchtige Kopfrechner.

Zeichnen ist ein fast allgemein geübtes Fach, ganz geeignet zur Pflege des Formen- und Schönheits sinnes—welcher sich in den schönen Arbeiten der Frauenarbeitschulen zeigt. Von den Lehrern der Volksschule wird übereinstimmend bemerkt, dass in den Volksschulen mit den *Mädchen ein höheres Lehrziel* erreicht wird, als mit den *Knaben.*

Eine nicht unwichtige *Eigenthümlichkeit der Württembergischen Culturzustände* ist darin zu finden, dass eine verhaltnissmässig beträchtliche Zahl der schulpflichtigen Knaben ihre Bildung in höheren Anstalten als deu Volksschulen sucht. Unter 150000 Knaben im Alter von 8—14 Jahren besuchten 13500 d. h. 9% Latein- oder Realschulen, der 11te Theil der männlichen Bevölkerung erlernt somit eine *fremde Sprache*; in der *Stadt Stuttgart* besuchen 65% der schulpflichtigen Knaben höhere Anstalten, nur 35% die gewöhnliche Volksschule; fast 2/3 der männlichen Bevölkerung erlernen hier alte und neue Sprachen; von etwa 5000 14 jährigen Knaben, die alljährlich als *Lehrlinge* in ein Gewerbe eintreten, kommen mehr als 1500, d. heisst 30% aus Latein- und Realschulen und 3500, d. heisst 70% aus Volksschulen.

Es beweist diess, dass in Württemberg die Keime und Ansätze einer höheren Bildung in Kreise getragen werden, die anderwärts ganz davon ausgeschlossen werden.

Nimmt man dazu die billigen Schulgelder und andere Staatsbenefizien, und Stipendien so kann man sagen dass in *Württemberg seltener als irgendwo anders* ein *Talent durch Mangel an Pflege verkümmert.*

Man hört jetzt oft im Lande die Klage *ueber zu viele höher gebildete Techniker* während ein Mangel an tüchtigen praktischen Arbeitern vorhanden sein soll, denen man die Stelle eines Vorarbeiters, Werkführers, uebertragen kann. Eine Hauptursache dieser Erscheinung liegt in der seit 1867 auch in Württemburg eingeführten *allgemeinen Wehrpflicht*; dabei wird demjenigen der das sogenante Einjährigen Examen macht, meist im Alter von 16-17 Jahren, das Beneficium der *einjährigen Dienstpflicht* eingeraeumt. Alle jungen Leute der Mittelclassen und mehr auch die der unteren Volksclassen suchen nun dieses Examen zu machen, um nur *ein Jahr lang Soldat* sein zu müssen, waehrend dessen sie sich selbst zu unterhalten haben; viele davon mögen später nicht mehr *praktische Arbeiter* werden, ziehen vor ein Amt zu bekleiden und wäre es auch nur ein solches mit dem bescheidensten sicheren Einkommen.

Unsere *Regierung* braucht bei ihren vielen Staatsbetrieben:—Eisenbahnen, Strassen, Telegraphen stehen ganz unter Staats verwaltung—einen *grossen Stab* von *technischen Beamten*, die erst mit 24—25 Jahren ihre Studien beendigen und Anstellung finden, also in vorgerückten Jahren—; auch in der *Privat industrie* ist es seit Jahren allgemeine Sitte geworden, die Söhne eine höhere technische Ausbildung erlangen zu lassen.

Bei unseren *technischen Hochschulen*—wenigstens soweit sie Maschinenbau und Electrotechnik besonders pflegen—hat sich das Bedürfniss herausgestellt, dem Unterrichte mehr und mehr eine praktische Richtung zu geben. Mehrere der deutschen technischen Hochschulen, so auch die in Stuttgart, werden desshalb in allernächster Zeit mit *umfassenden Maschinenbau-laboratien* zur Vornahme von Versuchen in grösserem Maasstabe ausgestattet ähnlich wie solche Einrichtungen schon an manchen *Americanischen* Anstalten bestehen.

Sir PHILIP MAGNUS thought it would be the general feeling of all present that they were very grateful indeed to Herr von Diefenbach for having written his paper, and explained it so well in our own language. He had had the pleasure of knowing him for some time, and could speak personally of his own indebtedness to him for having given all the information with regard to German schools which he went to Würtemberg to acquire. Those who had read the paper would recognise what a really interesting report he had placed before them, and what a deep insight it gave them into the working of the Würtemberg system. He was induced to make a remark upon it, because it touched upon many qnestions which they were discussing that morning. One point

was of very great importance. When a comparison was made between the progress of trade in this country and Germany, it was very common to say that the whole reason why the Germans were succeeding so well industrially was because the hours of labour here were so much shorter than in Germany. But they would see in Herr von Diefenbach's paper that he himself had stated that whilst the hours of labour in Germany used to be very much longer, perhaps, than they were in this country, the hours of labour there were now very much shortened, and that this had produced a very good effect upon the attendance in evening classes. And he thought they would also recognise the interest of the remarks made in the succeeding paragraph, that all the schools throughout even so small a place as Wurtemberg were not organised in the same model, but that the instruction was differently arranged so as to meet the requirements of particular districts. That was a distinguishing feature of their system. Then, they had been discussing that morning the vexed question of the best kind of teachers to have, and they would see that in Wurtemberg an effort was made to obtain, for all trade classes, educated workmen as teachers, and that there was felt the great importance of even trusting trade teaching to well-instructed tradesmen, to persons who were familiar with the practical working of their own trades and able to scientifically explain the principles which govern the practice. They would also see that they were endeavouring to introduce as far as possible trade workshops into their schools, and although they were not so forward in Würtemberg as in Switzerland or Austria, where they had the celebrated Fachschulen, they were, nevertheless, moving in the same direction. The obligatory age in Würtemberg was 14—a child must have completed his 14th year before leaving school. But then, there was something more important than that, for in Würtemberg a child was not allowed, after having left school at 14, to waste his time until any age he pleased and then at 18 to go to a technical school, having forgotten nearly everything he had learned in the elementary school, but attendance at the evening and Sunday schools then became obligatory, and it was to this fact that they owed in a great measure the intelligence of the German workman and his ability to take advantage of the technical instruction provided for him.

Mr. Wm. Woodall, M.P., said he rejoiced that they had had the opportunity of hearing Herr von Diefenbach, for he had given them much information upon which they might well ponder. He had told them how the experiment of educating the people of a State having a comparatively small population—a population less than that of Switzerland, but small indeed when compared with the population of our metropolis—had been practically limited within the last 50 years, and the expenditure upon that work had been so fully justified by the material profit which the State had realised, that public opinion sustained the Government and the Communes in that encouraging expenditure. But he was a little disappointed in one particular—and he noticed it in the course of previous discussions—and that was that whilst that Congress was specially invited to consider the very higher developments of technical instruction, they had been occupying their time—very profitably, he admitted—in going over the old and familiar ground of the education of the workman. Herr von Diefenbach might have told them how very large and generous was the expenditure in the very highest instruction and training of the captains of industry in Wurtemberg. There was nothing that impressed the visitor so much in that pleasant little capital of the State as the schools for electricity, for example, or the the Agricultural School, to which Herr von Diefenbach had referred, and the instruction that was there provided for men to take the very highest rank in electrical and mechanical pursuits. And let it be borne in mind that Würtemberg was one of the many States which composed the German Empire,, and although Würtemberg might take proper pride in the manner in which it had developed that kind of instruction, it had competitors with an almost similar story to tell. But we, at any rate, might hope to follow the example which had been so profitably set by Würtemberg in the development of higher education, and we might hope, some day or other, to bring order and co-ordination out of the chaos which now prevailed in our secondary school systems—though he confessed to have been a little disappointed that there was not any indication of any immediate intention in that direction given in the address with which their proceedings were opened on the previous day by the Duke of Devonshire. But, surely, such facts as they had heard deserve to be repeated again and again—that whilst Sir Philip Magnus had said the school age throughout the German empire was practically that of 14, the system of secondary and continuous education occupied the young men and women to an age long in advance of that—and those who felt, as he did, the humiliation of our sparse acquaintance with languages other than our own, must have been struck with the fact that whilst two-thirds of the children in attendance at the elementary schools were kept in attendance afterwards at continuation and secondary schools, two-thirds of those children, again, were taught a second language other than their own. They heard a great deal about the advantage which continental countries derived from having their young men in obligatory military service, but it was very impressive to find how much pains so large a proportion of those young men took to avoid, or, at any rate, to minimise the duration of that obligatory service to one year, and that undoubtedly had been utilised very profitably indeed by offering an inducement to a large proportion of the children of even the poorest to pass examinations which obtained their relief from all except one year's service. Here he might be disposed to give them some figures on the expenditure upon higher technical schools in

Stuttgart and elsewhere, except that they were given so fully and carefully in the report which his colleagues agreed upon and which was presented to Parliament by the Duke of Devonshire last autumn, and which, as it had not been referred to before, he referred to very confidently then. But it was impossible, visiting as they did the remarkable exhibition at Stuttgart, especially devoted to examples of the application of electricity to manufactures and the useful arts, not to be overwhelmed with the evidence of the profitable results that had accrued from the large and generous expenditure on education, from the elementary to the highest. Sir Henry Roscoe had referred to one of the great chemical factories which he had visited in Germany, where a number of highly-paid chemists were employed, the like of which found no parallel in England. But here the fact was brought home to us, that, whilst it was to Englishmen that we were indebted for the discovery of coal-tar colours, at the present time these coal-tars were sent from London to Germany and elsewhere to be converted into the beautiful dyes which we had to purchase back from them, and what had been done in so many departments in the application of chemistry to profitable manufactures was now being pursued with remarkable success in regard to the application of electricity. It was surely abundantly clear to them that it was only by the provision of the very highest facilities in technical and scientific instruction that we in England might hope to rival—he was afraid that he could not conceive it possible that we could excel—the remarkable success that had attended such enterprises in Germany.

A question was asked by a delegate as to whether employers of labour in Germany gave facilities for their workmen to attend classes. In England, for instance, great difficulty was experienced in getting a builder to send his masons to a school for carving.

Herr von DIEFENBACH said that 40 or 50 years ago the same conditions prevailed in Germany, but now it was quite a matter of course that a master sent all his apprentices to school, and the parents took care that the liberty of their sons to attend was stipulated in the indentures.

The CHAIRMAN pointed out that in a machine department in Saxony, which employed more than 3,000 workmen, all the youths who entered there had hours allotted to them during which they could attend a technical college to complete their education.

In answer to a further question from a delegate,

Herr von DIEFENBACH said that they did not teach a trade in the Wurtemberg schools, they expected the practice of the trade to be taught in the workshop, and the school was only to give a man theoretical knowledge.

Professor SILVANUS THOMPSON enquired as to the average pay of the teachers in evening continuation schools.

Herr von DIEFENBACH replied that they were generally paid per hour—about 3s. an hour for evening classes and sometimes more. There were very few teachers who were employed all their time.

The CHAIRMAN said it might also be interesting to know what the pupils pay.

Herr von DIEFENBACH replied—The fees are very small—about 10s. for six months, for attendance every day, including Sunday.

Mr. SNAPE (Liverpool) said that the difficulty of dealing with the question of half-timers, to which the Chairman had referred, had been brought home to him, as it had been brought home, he thought, to every Parliamentary candidate in Lancashire. One person had said to him, "I like you, and I hope you will win, but if you are going to raise the age for half-timers we shall vote against you." There was not a member likely to be returned for any textile industrial constituency south of Preston were he to say that he would support a proposal to raise the age. But something had to be done to prepare the pupils for the technical classes.

The CHAIRMAN said he was sorry to have heard the humiliating confession that no Parliamentary candidate in Lancashire would have a chance of being returned if he proposed to raise the age of half-timers. But they must be courageous on that point. He hoped that sound common sense would prevail over even the prejudices of Lancashire. When he entered Parliament children worked in factories in Lancashire at eight years of age. He fought that battle, and got it raised to ten, and it had since been raised to eleven years. There was more opposition both amongst workmen and masters to his original proposal to raise it from eight to ten than there was now the proposal to abolish it altogether. He intended to take the risk, whatever the consequences might be, of introducing a Bill to abolish the system altogether. He was ashamed, after having been in Parliament thirty years, to contrast our educational system with that of Switzerland and Belgium, and to think that we in England could not offer the same education to our children that those small States could.

SOME LIMITATIONS TO TECHNICAL INSTRUCTION.

By SIR JOSHUA FITCH, LL.D.

In an assembly composed mainly of those who are firmly convinced of the importance of technical instruction, and who are met to concert measures with a view to make such instruction more accessible and more efficient, it may not, it is hoped, seem irrelevant to invite attention briefly to one or two considerations bearing on the relation of such special training to the larger subject of general education, of which, of course, technical instruction forms a part. We can never form a true estimate of the worth of any kind of instruction—manual or intellectual—unless we see it in true perspective and proportion, and know the place it should occupy in a scheme of education which regards man in his totality, and not merely on his industrial or practical side.

We are all agreed that our schools have been for centuries too much absorbed in book-work, in verbal studies which sought to train memory and reasoning only, but which failed altogether to give adequate discipline for the eye and the hand, or to fit the scholar for skilled labour and for practical life. Parliament and public opinion have concurred in desiring to correct and supply this grave defect; and the Technical Instruction Act and the Local Taxation (Customs and Excise) Act are the national expression of a determination to do so. And these measures have already, as we all know, borne abundant fruit. No one can read, for example, the admirable and comprehensive report just presented to the London County Council by its Technical Education Board without seeing how completely the higher trades and the whole work of the skilled artisan in London will be transformed ere long by the well-devised efforts of that Board to give a more scientific character to the instruction of apprentices and workmen, and so to improve the quality of the work done by them. "In the building, engineering, printing, furniture, silver working, and leather trades in particular, the London artisan has now within easy reach at nominal fees opportunities for thoroughly perfecting himself in his trade. * * * Drawing, modelling, and design, which are in many respects the most valuable form of technical instruction for all crafts, are taught in 47 centres, besides many day schools and evening continuation schools." And then in detail the report enumerates the various classes, and the forms of trade work:—

(*a*). *Building*, with special instruction in bricklaying, brick-cutting, carpentry and joinery, masonry and stone carving, plumbing and plastering, besides practical and theoretical teaching in architecture and design for those who are aiming at the higher branches of the profession.

(*b*). *The metal trades*, including engineering, electrical fitting, lighting and plating, the work of goldsmiths, jewellers, and workers in silver, iron, and steel.

(*c*). *Book and printing trades*, including engraving, book-binding, lithography, classes for artistic design, photography, and the application of the several arts concerned in the production of books and illustrated papers.

(*d*). *The leather trades*, with the arts of tanning, dyeing, and dressing leather.

(*e*). *Furniture and carriage building.*

(f). Clothing and upholstery, which offer a very wide scope for skill, taste, and inventiveness.

The descriptions of the various classes engaged in these occupations, and the details of the various processes employed are full of suggestion and of interest, and inspire all of us with great hope. But every one of these manual employments has at its root some department of science. The nature of the material has to be studied, the laws of the various forces—chemical, mechanical or biological—need to be investigated, and it is an essential part of an intelligent system of technical training that it should be from the first scientific in its character, and not empirical. In all these trades every rule employed which is worth adopting, is founded on some principle or natural law which is worth investigating. But I cannot find in such experience as I have gained in technical institutions that attention enough is given to the scientific truths and principles which underlie the various forms of handicraft, and the knowledge of which makes all the difference between the mere mechanic and the intelligent artisan. I should not like to advocate the too early teaching of the science connected with a skilled trade. Still less does it seem to me to be well to encourage the desire on the part of the young student to accumulate certificates in a certain number of sciences—chemistry, electricity, sound, light and heat—and so forth. This practice has, unfortunately, been much encouraged in former times by the regulations of the Science and Art Department. It has led to the result that the young scholar measures his success by the number of sciences in which he is able to show a certain elementary knowledge, rather than by his thorough grasp of any one of those sciences, or even by his possession of the scientific temper and spirit at all. What we need is, that when the special *métier* of the student is found, and when he enters an appropriate department of the trade and technical school, he should unite the practice of the manual art and the knowledge of the rules of his craft with a thorough knowledge of the particular science which stands in the closest relation to that craft. All through the reports of the London Technical Committee, and of similar authorities in other parts of the country, I find constant complaints of the imperfect grounding which the students have received, and of the need of more general and cultivated intelligence before technical studies can be entered upon to any good purpose. Thus the report on some of the London Polytechnics calls attention to the importance of better training in workshop arithmetic. "Experience," says the report, "shows this to be a subject in which the young apprentice or artisan is usually very deficient, and this deficiency has been the greatest bar to the progress of the apprentice on entering the technical class." Again in the tailoring and dressmaking departments, where cutting out is indispensable, the report points out the value of a previous knowledge of practical geometry, and deplores the fact that even an elementary acquaintance with this subject has to be gained after the pupils have begun the practical course itself. All this points to the conclusion that there should be greater soundness in elementary knowledge, and that what is wanted is more thoroughness in the ordinary disciplinal work and studies of a good school rather than any premature exercises, specially adapted to anticipate a particular form of technical study.

I should like to learn the opinion of experts and especially of the teachers in technical institutes, as to the expediency of providing by the Education Department a "leaving certificate," which at the age of fourteen might serve to attest that the holder had passed with credit the Seventh Standard and two at least of the optional subjects, and might also serve as a sort of matriculation or entrance examination into a technical or higher school. This plan will be found at work in France and Belguim and in Germany, where the *certificat d'études* or the *abiturienten-examen* appropriate to the conclusion of the primary school course, is regarded as a necessary condition of admission to further educational privileges, and is also held in high estimation by employers of labour, many of whom require a youth to produce it before entering on employment. At present the practice of individual examination has fallen into disuse in our elementary schools chiefly because experience showed that it was an unsatisfactory way of assessing the money grant. But in the interests of the scholar, no less than in that of the thoroughness and accuracy of the school-work generally, I may suggest that a searching and authoritative individual examination should be instituted at the Seventh Standard; and that a certificate should be granted to those who had attended regularly, had borne a good character, had made a good use of their time and reached the standard of proficiency appropriate to the end of the primary school course. This plan would, I believe, be very welcome to good teachers, to whom it would afford an opportunity of distinguishing themselves. It would certainly be very acceptable to parents. It would greatly facilitate the entrance of promising boys and girls into suitable employment and into the public service. It would have a useful influence on the whole of the school course, and serve as a check upon slovenly teaching, and even possibly—with reverence be it spoken—upon slovenly inspection. It would provide a new motive for regular attendance, and it would certainly give to the conductors of technical and evening schools a better guarantee than they now possess of the fitness of the young scholar to enter upon advanced technical study. I submit to this Conference that its influence might be usefully directed to this point, and that the true co-ordination of elementary school work with the more developed industrial and scientific instruction in which the Conference is most interested, would be secured, in some degree, at least, by the adoption, as an integral part of our elementary school system, of the "leaving examination" at 14, and the award, by the Education Department, through its inspectors, of an appropriate certificate.

Nothing struck me so much in visiting the *apprentice schools*, the *technical schools*, the *ecoles des arts et métiers*, of the continent, as the constant insistence on the pursuit of some of the humanising or formative studies, concurrently with the special studies bearing on trade and industry. At the *Ecole Diderot* for boys, and at the *Ecoles professionelles* for girls, as I have elsewhere shown in an official report,* one half of the day is devoted to the special teaching and discipline connected with the pupil's selected trade; but the morning of every day is spent in the study of literature, in drawing, in mathematics, in composition of themes, and in general scientific training. No one is admitted to the *atelier*, or work-room, in the afternoon, who does not regularly attend the morning classes, and it is the testimony of the directors of these institutions, that unless the cultivation of the intelligence and the general capacity of the pupil were attended to, *pari passu*, with the hand-work of the apprentice or the trade school, technical instruction would prove incomplete and of small value, and would fail to fufil even its own highest purpose.

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* "Memorandum on the Working of the Free School System in America, France, and Belgium." Presented to both Houses of Parliament, in 1896.

Many of you are familiar with the experience of Socrates, as it is recounted in the *Apologia*. "I betook myself," he says, "to the workshops of the artisans, for here, methought, I shall certainly find some new and beautiful knowledge, such as the philosophers do not possess. And this was true, for the workmen could produce many useful and ingenious things." But he goes on to express his disappointment at the intellectual condition of the artisans; their bounded horizons, their incapacity for reasoning, their disdain for other knowledge than their own, and the lack among them of any general mental cultivation or of any strong love of truth for its own sake. He thought that mere skill in handicraft and mere acquaintance with the materials, and with the physical forces employed in a trade, could carry a man no great way in the cultivation of himself and might leave him a very ill-educated person; that, in fact, the man was more important even than the mechanic or the trader, and that in order to be qualified for any of the employments of life, and to be prepared for all emergencies, mental training should go on side by side with with the discipline needed for the bread-winning arts.

We have at hand some more recent experience illustrating the same truth. There has been for many years in our elementary schools one kind of manual and technical work specially subsidised by the State, and indeed enforced as an indispensable condition of receiving any aid or recognition from the Education Department at all. I mean needlework in girls' schools. It fulfils for girls all the conditions which the advocates of technical instruction have in view for boys. It has unquestionable utility. It affords training for eye and hand. It demands attention, accuracy, and dexterity; and it has an economic value, as a means by which the home may be improved, and money may be earned. It enlists a good deal of sympathy among managers, and the Lady Bountiful or the vicar's wife in a country village is often well content to see the half of every schoolday spent, not indeed in learning to sew, but in manufacturing garments for home use or for sale. It is thought by many good people to be the most appropriate of all school exercises for girls. It seems so domestic, so feminine, so practical. Perhaps it may seem ungracious to inquire too curiously into the effect of this kind of exercise upon the general capacity of the scholars, and upon the formation of their characters. But as a matter of fact, the exercise is often dull and mechanical, it keeps children dawdling for hours over the production of results which, with more skilful and intelligent teaching, might be produced in one-fourth of the time. The place in which the work is done becomes rather a factory than a school, and measures its usefulness rather by the number of garments it can finish than by the number of bright, handy, and intelligent scholars it can turn out. In fact, it is found that proficiency in needlework may co-exist with complete intellectual stagnation, and that the general cultivation of the children, their interest in reading and inquiring has been too often sacrificed to the desire for visible and material results. Some of the sewing is designated with curious irony, *fancy* work. But there is little or no room in it for fancy or inventiveness, or even for the exercise of any originality or taste. So while fully conceding the importance of needlework as an integral part of the primary education of the girls in our schools, I think we are all interested in economising the time devoted to this work, in seeking to employ better methods of obtaining results, and above all in remembering that the educational value of mere handiwork is in itself very limited, and that it ought to be supplemented by other discipline if we desire to make the best of our material and to send into the world capable and thoughtful women, ready for the varied duties of domestic and industrial life.

You will anticipate the inference, which from my own point of view, as an old inspector of schools and training colleges, I am inclined to deduce from these considerations. I entirely admit that our school instruction has long been too bookish, too little practical, and that the friends of technical instruction are fully justified in calling attention to the grave deficiencies in our system, especially to the want of sounder teaching in physical science, and of better training in the application of those sciences, to the enrichment of the community and to the practical business of life. And we are all agreed, too, in the belief that apart from the industrial and economic results of better manual instruction, there may be in such instruction a high educational purpose, that it may tell on character, awaken dormant faculty, teach the better use of the senses, and increase the power of the human instrument over matter, and over the difficulties of life. Only do not let us exaggerate the educational value of manual instruction, or suppose that all our difficulties are to be solved by turning our schools into workshops. Without co-ordinate intellectual training and development, manual training will only accomplish a part, and not the highest part of the work which lies before the teachers of the future. Let us recognise its necessary limitations. And we can do this in at least two ways, *first*, by aiming at a higher standard of general intellectual culture in the schools from which technical schools are recruited, and thus securing a more solid groundwork for our special instruction. And the *second* expedient is to urge, whenever possible, upon each of the young people in our trade and evening classes, to take up one subject at least—it may be history or mathematics, or philosophy, or a foreign language—which has no direct or visible relation to his trade or to the means whereby he hopes to get a living, but is simply chosen because he likes it, because his own character is enriched and strengthened by it, because it helps to give him a wider outlook upon the world of nature, of books and of men, and because he may thus prepare himself better for the duties of a citizen and a parent, as well as for an honoured place in the ranks of industry.

The CHAIRMAN said he did not know whether there was any disposition to discuss the admirable paper which Sir Joshua Fitch had just read to them. He thought they would perhaps best show their appreciation by carefnlly reading the excellent principles he had laid down, for he had very opportunely intervened to remind them that a living was not a life, and that the building up of character was as important a function of education as the increase of knowledge.

[The Report of the Congress will be continued in the next number of the *Journal.*]

Miscellaneous.

PEASANT PROPRIETORS IN MAURITIUS.

According to the last report of the Colonial Secretary of Mauritius the most noticeable feature in agriculture during the year has been the great increase in production of canes by small cultivators. These are almost entirely confined to the Indian classes, generally men who have worked out their indentures, and who, having saved a little money, are able to purchase their own small patches of land. It is exceedingly difficult to estimate the total quantity of land under this kind of cultivation, as no official return is yet made of the area cultivated by what may be termed peasant proprietors. Such a return might also show the amount of land under canes on estates where their are no mills, and the quantity of sugar made from the produce of such lands, and in the present transitory condition of the arable land in Mauritius would be an important and an interesting document. The Indian, having acquired his small patch of property, is able to turn his industrious habits to good account, for while on the large estates the labour force is carefully protected by Government, and a system of task-work has gradually been accepted which brings the effective labour to a minimum compared with the nominal labour force employed. The Indian peasant proprietor works early and late, and it is no uncommon sight to see men who have finished their task on estates, working on their own patches after hours, assisted by every member of their families. During the year 1895 much land changed hands, and the "amorcellement," or sale in small lots, of estates affords the opportunity to the Indian to acquire property. That the movement will go on at an increasing pace is inevitable, and a significant fact is that many proprietors are increasing the power of their factories in view of buying the canes produced by these small planters. Thus the central factory system is within the sphere of practical economics, and with large areas of land coming into the market, and the increasing scarcity of labour, it is more than ever probable that the process of manufacture will eventually be entirely separated from the production of the raw material. Such a division of labour will undoubtedly be for the benefit of the Colony in giving that profit which under the existing system is not sufficiently certain to have the effect of attracting capital.

SAN FRANCISCO RAILWAYS.—During the past year about 275 miles of railway have been constructed in the consular district of San Francisco. The chief work was on the San Joaquin Valley Railway, which reaches from Stockton to Fresno, a distance of 125 miles. As soon as the necessary right of way shall have been secured, the line will be carried on southwards to Bakersfield. There is inter-communication between Stockton and San Francisco—in addition to a railway, a portion of the Southern Pacific system—and this will give communication between Bakersfield and San Francisco, in competition with that system. It is intended to extend the San Joaquin Valley line as soon as possible to San Francisco, and surveys for the purpose are being made. The promoters hope eventually to get access to the east from Bakersfield.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CHAIRMANSHIP OF COUNCIL.

On Monday, 13th inst., at their first meeting after the annual election, the Council elected Major-Gen. Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., as Chairman of the Council for the ensuing year. The various Committees were also re-appointed.

International Congress on Technical Education.

WEDNESDAY AFTERNOON, 16TH JUNE.

Section A.—*(continued)*.

The Right Hon. A. J. Mundella, M.P., in the chair.

L'ENSEIGNEMENT PROFESSIONNEL ET L'INITIATIVE PRIVÉE EN BELGIQUE.

By Oscar Pyfferoen.

Docteur en Droit, Docteur en Sciences politiques et administratives. Professeur à l'Université de Gand.

Les efforts des particuliers pour créer à leurs frais et par leurs sacrifices personnels l'enseignement professionnel se sont manifestés en Angleterre sous la forme de Polytechnics et d'Ecoles Techniques grandioses créées à l'aide des millions souscrits ou donnés par les citoyens. L'Allemagne a organisé presque tout son enseignement professionnel, surtout celui des petits métiers et de la petite industrie, par la seule initiative des corporations. D'innombrables écoles de tailleurs, cordonniers, menuisiers, ébénistes, vanniers, coiffeurs, patissiers, ramoneurs, ferblantiers, serruriers, peintres, etc., ont été fondées et entretenues par les artisans exerçant ces professions et groupés en corporations. Ce n'est que plus tard, lorsque l'expérience tentée eût prouvé leur viabilité et leurs heureux résultats que quelques-uns des Etats allemands vinrent au secours de ces écoles et leur fournirent de légers subsides, à peine suffisants pour combler le déficit que la meilleure volonté des membres des Corporations ne pouvait prévenir. Plus encore que les gouvernements des Etats, les Administrations Communales, comme celles de Berlin ou de Dresde, allouèrent des subventions à ces œuvres d'instruction technique. Souvent aussi les pouvoirs publics profitèrent de la pénurie de ressources des écoles professionnelles privées pour les reprendre complètement à leur compte, les réorganiser et leur donner un nouvel essor.

En Belgique les tendances de l'esprit public s'inspiraient davantage des mœurs françaises. On attendait presque tout de l'Etat. C'est l'Etat qui a fondé les Ecoles industrielles; elles sont prospères et efficaces. C'est donc aussi à l'Etat, disait-on, à fonder les Ecoles professionnelles. Ainsi raisonnaient ceux-là mêmes qui avaient fondé ou qui entretenaient à leurs frais d'innombrables établissements d'instruction non technique, écoles primaires, écoles moyennes, collèges et universités. Dès qu'il s'agissait d'enseignement professionnel on ne voyait plus que le Dieu-Etat.

Aussi fut-on longtemps à n'avoir qu'une ou deux écoles professionnelles du bois et du fer, notamment à Gand et à Tournai, quelques rares cours professionnels dans les écoles industrielles, et des ateliers d'apprentissage à la campagne pour les textiles et dans le Hainaut pour la taille des pierres.

Que les industriels ou les artisans n'aient pas songé plus tôt à créer des écoles professionnelles, cela s'explique par plusieurs motifs.

Tout d'abord ils ne comprenaient pas assez l'utilité, la nécessité de cette instruction pour y affecter des sommes considérables prises sur leurs propres deniers. Et ceux qui en concevaient l'opportunité estimaient peu sage de faire à leurs propres frais l'éducation professionnelle des autres. Ne pouvant plus, à raison de leur âge ou de leur situation, profiter de cet enseignement, ils aimaient mieux qu'autrui ne pût pas en profiter davantage. Ceux-là mêmes qui étaient convaincus de l'importance pour l'industrie nationale et pour leur personnel en particulier d'une instruction technique suffisante et complète, ne pouvaient se décider à supporter seuls la dépense entière à résulter de l'institution d'écoles utiles à tous.

Depuis quelques années ces objections et ces préjugés disparaissent; la situation tend à changer quelque peu. Le gouvernement lui-même, l'honorable ministre de l'industrie et du travail, M. Nyssens, encourage par tous les moyens l'initiative privée; il s'efforce de la susciter par l'espérance d'un appui financier. Les

Rapports sur l'Enseignement Professionnel en Angleterre et en Allemagne que j'ai été chargé de présenter à M. le Ministre et qu'il a bien voulu faire publier ont, entre autres, pour but de montrer les résultats obtenus dans ces deux pays par le concours des particuliers ou par leur seule initiative. Aussi peut-on dire que nos écoles professionnelles se sont multipliées dans une forte proportion depuis quelques années, et que de grands progrès ont été réalisés en peu de temps.

Le subside de l'Etat pour l'enseignement industriel et professionnel a été presque doublé depuis la création du ministère de l'industrie et du travail; dans le budget de 1898, il s'élèvera à 850,000 francs. Il sert en grande partie à soutenir les établissements libres.

A l'heure actuelle l'initiative privée se manifeste en matière d'enseignement professionnel sous trois ou quatre formes principales.

Tout d'abord on a vu quelques *groupes d'artisans ou d'ouvriers,* réunis en Syndicats ou spécialement associés pour cet objet, décider la création d'écoles de métiers et solliciter à cet effet les subsides de l'Etat des communes ou des provinces. Eux-mêmes ne supportaient qu'une très faible part des charges financières. C'étaient en général des patrons, convaincus du besoin de suppléer à la décadence de l'apprentissage, peu désireux de former des apprentis à domicile suivant l'ancien régime; ils constituaient un comité de patronage de l'école à créer, se chargeaient de la surveillance et de l'administration, et se réservaient la nomination des professeurs. Ainsi furent créées entre autres les écoles de tailleurs à Bruxelles et Liège, les écoles de tapissiers-garnisseurs, d'horlogers, de bijoutiers et de coiffeurs à Bruxelles, d'armuriers à Liège, les écoles de brasserie à Gand. L'école de typographie de Bruxelles a été créée par un syndicat d'ouvriers, également à l'aide des subsides des pouvoirs publics.

L'origine de ces diverses écoles fait qu'elles sont demeurées autant d'écoles séparées. On ne trouve pas, comme dans les Polytechnics et les Ecoles anglaises, tout cet enseignement concentré entre les mêmes mains, sous une direction unique. De là une grande variété dans les méthodes, les heures de cours, les conditions d'admission.

Le plus souvent ce sont des écoles du jour, c'est-à-dire des ateliers d'apprentissage plutôt que de simples cours professionnels. Les élèves sont tenus de rester toute la journée à l'école pendant plusieurs années. Ce n'est nullement le système si pratique adopté en Angleterre: l'apprentissage à l'atelier, complété par l'instruction théorique et pratique à l'école; ce n'est pas l'école complément de l'atelier; c'est au contraire l'école se substituant à l'atelier, prétendant former chez elle des ouvriers tout faits.

Il en résulte que l'on est en général obligé de payer les élèves pour les faire venir à l'école. Privés de tout salaire industriel pendant les deux ou trois années de cours à l'école, les apprentis tailleurs, par exemple, réclament en compensation une sorte de salaire pour le travail qu'ils font aux ateliers scolaires. Sans cette indemnité les parents refuseraient d'envoyer leurs enfants à l'école et préféreraient les faire travailler dès le premier jour à l'atelier d'un patron. Même malgré cette rémunération attachée au travail de l'élève, beaucoup de parents ne peuvent se résigner au sacrifice d'un salaire plus élevé et plus immédiat que procurerait le travail à l'usine. D'autre part dans la petite bourgeoisie, cette classe de la population qui vit essentiellement des petits métiers, il existe une forte opposition contre les ateliers scolaires à raison même de leur organisation en écoles du jour. Travaillant toute la journée, ces écoles produisent parfois beaucoup. Elles ne sont pas au même titre que les particuliers soumis au régime de la concurrence commerciale; elles peuvent vendre leurs travaux à toute offre acceptable. Dès lors les petits patrons se plaignent de la concurrence que leur font ces établissements subsidiés par les pouvoirs publics à l'aide de l'argent des contribuables.

A ces diverses objections il serait certes facile de remédier, et je me hâte de dire que bon nombre de nos écoles professionnelles y échappent. Il suffit d'organiser l'enseignement professionnel théorique et pratique dans des cours du soir. Cela permet la fréquentation des cours à ceux qui travaillent durant la journée chez leur patron, gagnent un salaire proportionné à leurs forces et à leur habileté, et qui viennent après leur journée de travail, se perfectionner aux classes et aux ateliers scolaires, y apprendre ce qu'à l'atelier le patron ou le contremaître n'a pas voulu ou n'a pas su leur expliquer. Cela dispense aussi les ateliers scolaires de jeter sur le marché le produit du travail de leurs élèves; car ce travail ne se borne plus alors qu'à trois ou quatre heures par semaine, et la question du placement des objets manufacturés ne se pose plus.

L'école de typographie, de Bruxelles, par exemple, est une école du soir. Les ouvriers qui l'ont fondée se sont bien rendu compte sous ce rapport de la réalité de leurs besoins économiques. Chez eux aussi, à la différence de ce qui existe d'habitude ailleurs, on n'admet aux cours pratiques que ceux qui exercent déjà la profession dans laquelle ils veulent venir se perfectionner à l'école. Le syndicat ouvrier a voulu que l'école professionnelle ne servît pas à augmenter d'une façon artificielle le nombre de bras dans la profession, mais qu'elle contribuât à améliorer l'ouvrier, à accroître sa valeur productive, et par conséquent à lui faire mériter de plus hauts salaires. On a vu, au contraire, dans une autre industrie, la métallurgie, une crise économique grave éclater à propos d'une école professionnelle qui avait formé dans des cours du jour un grand nombre de jeunes apprentis. Ces nouveaux éléments, jetés tout coup dans la circulation, c'est-à-dire entrant tous au même moment dans les ateliers, venaient y déprécier les salaires, occuper la place d'ouvriers faits, susciter la jalousie des compagnons. De là une grève qui eut les plus fâcheuses conséquences pour l'industrie.

Quoiqu'il en soit, a part quelques réformes de détail dans leur organisation, ces écoles professionnelles, qui ressemblent beaucoup aux écoles de corporations allemandes, sont utiles, elles se développent constamment et leur nombre augmente d'année en année.

Un autre type de créations de l'initiative privée, type que je pourrais qualifier d'essentiellement belge, ce sont les établissements fondés par les congrégations religieuses. J'en signalerai trois principales catégories.

Les Académies de dessin et *Ecoles professionnelles Saint Luc* sont la première et la plus importante de ces catégories. Elles sont dirigées par les Frères de la Doctrine Chrétienne ; il en existe à Gand, Tournai, Liège et Bruxelles. Elles ont d'abord pour but, notamment dans l'esprit de leur fondateur, feu le baron Béthune, de renover l'art gothique en notre pays. Aujourd'hui quelques-unes au moins d'entre elles sont devenues plus éclectiques, et elles s'attachent à appliquer aux beaux-arts, surtout à l'architecture, des principes conformes aux differentes ressources et aux divers matériaux du pays. La plupart des Ecoles Saint Luc ne sont que des écoles de dessin et d'enseignement professionnel théorique, elles s'efforcent d'enseigner les métiers et les arts industriels par l'étude du dessin. Il en est toutefois qui sont allé plus loin. Telle l'Ecole de Tournai, qui a installé d'excellents ateliers de travaux pratiques. A Gand, les élèves de l'Ecole Saint Luc sont placés par les soins de leurs maîtres, les Frères de la Doctrine Chrétienne, auprès de patrons intelligents et dévoués chez lesquels l'ancien mode apprentissage est resté en honneur. Jusqu'à une époque toute récente les Ecoles Saint Luc subsistaient sans aucun subside officiel. L'octroi de semblables subsides leur permettra désormais de prendre un nouvel essor.

Les Ecoles Saint Luc sont exclusivement des écoles d'externes. En même temps, l'enseignement professionnel acquérait une place assez considérable dans quelques *pensionnats tenus par des religieux*. Il en était surtout ainsi dans des orphelinats et collèges destinés aux enfants pauvres et aux fils de famille peu aisées, c'est-à-dire à ces jeunes gens qui devront vivre plus tard du travail de leurs mains. Il est rationnel en effet de leur apprendre un métier plutôt que le latin et le grec, que la littérature ou d'autres branches qui ne leur serviront de rien par la suite, et les détourneront plutôt de la profession pour laquelle ils sont tout indiqués.

Il existe actuellement des cours théoriques et pratiques de tailleurs, cordonniers, menuisiers, imprimeurs, relieurs, voire même de plombiers, serruriers et horlogers auprès de divers collèges : nous citerons seulement ceux des Prêtres Salésiens à Liège (Œuvre de dom Bosco), des Frères de Notre Dame de Lourdes à Oostacker et Maltebrugge. Tandis que les premiers sont restés des écoles d'internes, dont l'école de métiers n'est accessible qu'aux pensionnaires, les seconds ont fait un pas de plus dans la voie du progrès. Ils ont rendu leurs cours et ateliers accessibles aux élèves externes, et en particulier à ceux qui se trouvent en apprentissage chez quelque artisan du dehors et veulent venir se perfectionner chez les Frères.

Ces ateliers scolaires travaillent tous durant la journée entière. Les Frères font exécuter des travaux pour leur congrégation ou des commandes qu'ils parviennent à obtenir de la clientèle privée. Les jeunes gens ne touchent aucun salaire ; mais ils sont logés, vêtus et nourris par l'établissement. Ils restent chez les Frères pour y faire leur apprentissage pendant cinq ou six ans. La longue durée de cet apprentissage, l'absence de stimulant chez les jeunes gens formés dans ces écoles, où ils demeurent nécessairement étrangers aux conditions de production des ateliers industriels, sont les objections principales que l'on fait, à tort ou à raison, à ce mode d'instruction. On reproche aussi parfois à ces établissements de faire la concurrence à l'industrie privée ; mais c'est là un grief qui ne porte pas contre l'enseignement professionnel proprement dit, mais contre ce que l'on appelle communément le travail des couvents. Or il est certes difficile, en saine économie politique, d'empêcher une classe de citoyens de vivre en se contentant de peu, et de produire, grâce à leur sobriété, à des conditions plus avantageuses.

Ce que ces établissements de Frères sont pour les jeunes gens, les *ouvroirs* le sont pour les jeunes filles. On appelle ainsi des ateliers tenus le plus souvent par des religieuses, parfois aussi par des dames laïques, où les jeunes filles peuvent venir s'exercer aux travaux manuels, apprendre la couture, la confection, la coupe, la broderie. D'ordinaire le produit du travail sert à couvrir les frais de l'ouvroir, et il y suffit dans la plupart des cas. La charité privée supplée, au besoin, au déficit. Ces ouvroirs existent de longue date.

Nous y rattacherons les *écoles ménagères*. Toutes nos villes et beaucoup de localités rurales ont aujourd'hui des cours d'économie domestique, des classes de cuisine et de lessivage ; elles sont rattachées le plus fréquemment aux écoles primaires de filles, aussi bien aux écoles libres qu'aux écoles communales. Des dames patronesses parmi lesquelles on compte l'élite de la noblesse et des membres de la famille royale, s'intéressent à ces œuvres, les encouragent de leur présence, les surveillent, et subviennent à une bonne partie de leurs dépenses.

L'enseignement commercial a donné lieu à d'autres formes d'activité de l'initiative privée. La Belgique possédait depuis longtemps un établissement de premier ordre, l'Institut Supérieur de Commerce d'Anvers, qui est une école de l'Etat. Tout récemment deux institutions similaires se sont fondées par l'initiative des particuliers : à la Louvière, un collège religieux s'est annexée une section de sciences commerciales qui veut égaler et même dépasser Anvers, et à Liège un projet analogue a été conçu. Ajoutons que la Maison de Melle-lez-Gand a créé aussi une Ecole de Commerce excellente.

Au degré élémentaire de l'instruction commerciale, c'est encore l'initiative privée qui est venue combler les lacunes.

Dans les villes commerçantes, le besoin s'était fait sentir pour la nombreuse catégorie des commis et employés d'une part, pour les détaillants et négociants d'autre part, d'avoir des connaissances plus approfondies en langues étrangères, comptabilité et tenue de livres, sciences commerciales. Cet enseignement, qui existe d'une façon si complète à Londres, par exemple, dans les Polytechnics, manquait encore, ou n'était pas suffisamment rendu accessible au public. Il s'est donc créé des institutions qui se sont donné pour but de dispenser cet enseignement dans des cours du soir, à des prix extrêmement réduits, abordables pour tous. Ce fut le *Cercle Polyglotte* de Liège qui donna l'exemple. Il possède à lui seul 500 élèves et membres, qui tous paient leur cotisation. Il fut bientôt suivi d'institutions analogues dans les autres villes. Les associations de voyageurs et syndicats d'employés ont aussi, dans plusieurs villes, ouvert des cours du soir de langues étrangères, auxquels le gouvernement accorde d'assez larges subsides.

Nous ne pretendons pas avoir énuméré toutes les formes d'action de l'initiative privée dans le domaine de l'enseignement professionnel. Il est impossible que semblable énumération soit complète, puisque ces formes varient à l'infini et que de nouvelles combinaisons se trouvent tous les jours. Il serait encore plus difficile de produire des chiffres relativement au budget ou au nombre d'élèves ou de professeurs des écoles libres, d'autant plus que la statistique de notre enseignement professionnel et industriel n'a plus paru depuis 1884.

Une on deux autres constatations s'imposeant encore à l'observateur impartial, desireux de se rendre completement compte de l'influence de certains groups de particuliers sur le développment de l'enseignement professionnel.

L'esprit de *parti* s'est mêlé à l'instruction technique, dans un sens qui, par exception produit ici d'heureux résultats. Tel syndicat socialiste ou antisocialiste crée pour ses membres des cours de peinture ou de couture : c'est le système de l'instruction mutuelle, qui peut être non moins fécond que celui de l'assurance mutuelle.

Là où elles ne fondent pas de cours distincts, associations de caractère principalement politique engagent leurs membres à suivre les cours des écoles industrielles et professionnelles : c'est le cas pour les syndicats socialistes à Gand, l'union professionelle des tisserands supporte même les frais que la fréquentation des cours peut occasionner à ses membres, tels que les achats de livres et fournitures classiques.

Il est plus rare de voir les *grands industriels* favoriser notre enseignement industriel de largesses princières comme les anglais ont coutume de le faire à leurs Ecoles Techniques. Le seul exemple que l'on puisse citer dans ce sens est celui de Verviers, où les listes de souscription ont produit des centaines de mille francs. A cet égard nous envions même ce qui a été fait dans le Nord de la France, à Roubaix et à Tourcoing, où, sans la moindre subvention gouvernementale, départementale ou municipale, ont été fondées de remarquables écoles de filature, de tissage et de teinture.

Tel est l'état actuel des œuvres de l'initiative privée en ce qui concerne l'instruction technique. Si elles ont pu prendre un développement aussi varié, c'est grâce à nos institutions libérales et aux encouragements bienveillants des pouvoirs publics. Nous n'avons pas encore de législation régulière sur l'enseignement professionnel, comme il en existe pour l'enseignement primaire, moyen et supérieur. Jusqu'à présent on n'a procédé qu'empiriquement. Il semble que la tendance, en fait, soit d'appliquer à l'instruction technique le principe en vigueur pour l'instruction primaire : l'octroi de subsides assez élevés aux écoles libres en même temps que le maintien, aux frais de l'Etat, des provinces et des communes, d'écoles officielles, qui serviront aux autres de modèles ou de stimulants, ou qui combleront tout simplement les lacunes de l'initiative privée.

Enfin il est une réforme qui se réalisera peut-être à une date prochaine et qui pourra donner une forte impulsion à la création d'écoles professionnelles : c'est l'octroi de la personnification civile. Dans le droit actuel, les écoles libres ne sont pas des êtres juridiques, elles ne peuvent ni recevoir ni donner, ni être propriétaires. Elles ont une situation instable ; leur avenir n'est pas assuré. L'Angleterre a trouvé le système si pratique des *trust committees*, administrant les écoles avec une entière liberté. Nous attendons impatiemment en Belgique d'être dotés d'un pareil organisme, et de la reconnaissance juridique des établissements d'instruction professionnelle.

L'ENSEIGNEMENT TECHNIQUE ET COMMERCIAL EN BELGIQUE.

PAR EDOUARD SÈVE.
Consul-General for Belgium.

I.

Le Comité du Congrès de l'Enseignement Technique m'a fait l'honneur de me demander un rapport sur la Belgique.

Le Ministre de l'Industrie et du Travail, M. M. Nyssens, a délégué pour représenter officiellement le Gouvernement du Roi à ce Congrès : M. Eugène Rombaut, l'éminent Inspecteur Général de l'enseignement industriel et professionnel du royaume, connu de tous ceux qui se préoccupent de la diffusion de l'instruction technique et manuelle : M. Wauters, l'Inspecteur-adjoint de la même administration et M. Oscar Pyfferoen, professeur à l'université de Gand, docteur en droit, docteur en sciences politiques et administratives, auteur d'un remarquable rapport sur l'enseignement professionnel en Angleterre publié par la direction de l'industrie, du ministère de l'industrie et du travail ; ces messieurs fourniront au Congrès tous les renseignements désirables sur l'organisation de nos établissements et leurs programmes.

Je me contenterai donc d'exposer à grands traits ce que nous avons fait en Belgique me tenant entièrement à la disposition de ceux des membres du Congrès qui désirent obtenir de plus amples informations sur le fonctionnement de nos universités et instituts et de nos écoles.

Me plaçant au point de vue belge et partageant l'opinion de M. Pyfferoen, je pense qu'il faut entendre par enseignement professionnel cette instruction qui prépare plus particulièrement à l'exercice des professions manuelles, des métiers et du commerce et je me rallie à son indication de classification de l'enseignement technique. Nos Ecoles professionnelles constituent le degré élémentaire de cet enseignement ; les Ecoles industrielles le degré moyen ; enfin, les Ecoles des arts et manufactures, les Ecoles des mines, les Ecoles du génie civil annexées à nos universités, le degré supérieur.

II.

Aucun document officiel ne nous renseigne sur la situation générale de l'enseignement industriel et professionnel depuis 1884. Le prochain rapport est sous presse ; il paraitra cette année.

L'organisation de l'enseignement supérieur en Belgique a pour base l'article de la Constitution qui décrète la liberté d'enseignement.

Nous avons actuellement 4 Universités, 2 appartenant à l'Etat, celle de Liège et celle de Gand, et 2 Universités libres, l'une à Louvain, l'autre à Bruxelles.

Les Universités comprennent plusieurs facultés :—Philosophie ès lettres, droit, sciences et médecine ; l'Université de Louvain possède, en plus, une faculté de théologie, placée sous la haute surveillance de l'épiscopat catholique belge et l'Université de Bruxelles a joint, depuis 1873, à sa faculté des sciences, une école polytechnique destinée à enseigner les applications des sciences aux arts et à l'industrie, comprenant les sections suivantes: exploitation des mines, métallurgie, chimie industrielle, construction des machines, génie civil, architecture.

Les Universités délivrent des certificats ou des diplômes de candidat et docteur en sciences naturelles, en sciences physiques et mathématiques. Le diplôme mentionne si le récipiendaire a subi l'examen d'une *manière satisfaisante*, avec *distinction*, avec *grande distinction*, ou *avec la plus grande distinction*. Tout examen est public.

Un certain nombre d'écoles supérieures sont venues se grouper autour des facultés universitaires; l'enseignement professionnel est rattaché aux facultés des sciences.

Les Universités belges possèdent chacune des Ecoles spéciales d'ingénieurs et d'architectes; mais les deux Universités de Liège et de Gand ont seules le privilège de préparer des ingénieurs pour le service de l'Etat: celle de Liège assure le recrutement des ingénieurs des mines, celle de Gand celui des ingénieurs et conducteurs des ponts-et-chaussées.

L'Ecole des arts et manufactures et des mines de Liège, dont l'origine remonte à 1825, comprend actuellement quatre divisions:—*l'Ecole des mines, l'Ecole des arts et manufactures, la section des élèves mécaniciens, et la section des élèves électriciens*. Ces quatre divisions de la faculté technique conduisent respectivement aux diplômes—

1. d'Ingénieur honoraire ou d'Ingénieur civil des mines;
2. d'Ingénieur civil des arts et manufactures;
3. d'Ingénieur civil mécanicien;
4. d'Ingénieur électricien.

L'enseignement est très fortement organisé; des collections de modèles extrêmement riches, des laboratoires bien montés, un personnel assistant considérable sont à la disposition des étudiants; des excursions dans les mines et dans les usines si nombreuses dans la province de Liège complètent l'instruction technique.

L'enseignement de l'électricité appliquée a pris dans ces dernières années une grande extension.

Une Ecole spéciale du génie civil est annexée à l'Université de Gand: la division inférieure est consacrée à la formation de conducteurs et la division supérieure à la formation d'ingénieurs; une partie du semestre d'été est réservée aux exercices pratiques, à la connaissance des professions qui ont pour objet l'emploi de la pierre, du bois ou du fer dans les constructions.

A côté de l'*Ecole du génie civil*, l'Université de Gand possède une *Ecole des arts et manufactures* destinée aux élèves qui veulent obtenir le diplôme d'Ingénieur industriel; cette école embrasse, dans le cadre de son instruction, tout le système des connaissances nécessaires pour l'application des sciences aux procédés généraux de l'industrie et aux principales branches des fabrications spéciales. Elle comprend une division préparatoire aux deux années d'étude et une division d'application désignée sous le nom d'Ecole spéciale des arts et manufactures dans laquelle les études durent également deux années.

L'Ecole des arts et manufactures est accessible aux élèves de toutes les nationalités.

A la faculté des sciences de l'Université de Louvain sont rattachées, depuis 1865, une *Ecole spéciale des arts et manufactures*, du *génie civil et des mines*, et une *Ecole supérieure d'agriculture*.

La première comprend cinq sections:—

L'exploitation des mines, métallurgie, chimie industrielle, génie civil, constructions mécaniques.

Les élèves qui suivent les cours scientifiques, techniques et pratiques sont partagés en trois catégories pour l'obtention des diplômes.

Les programmes comprennent un cours d'applications industrielles de l'électricité et des visites aux établissements où elles sont réalisées.

Les cours de l'Ecole d'agriculture ou Institut agronomique durent trois années.

Les Ecoles spéciales annexées aux Universités dont je viens de parler comprenaient, en 1895, une population qu'il est intéressant de constater.

Sur 640 élèves fréquentant l'Université de Gand, 216 figurent dans les écoles spéciales, soit 145 pour le génie civil et 71 pour les arts et manufactures. A l'Unversité de Liège, sur un nombre total d'étudiants de 1,248, 222 fréquentant la Faculté technique, titre donné par la loi du 30 Juin 1893, aux écoles spéciales des arts et manufactures et des mines. L'Université de Louvain, sur un total de 1,636, comprend 433 étudiants fréquentant les écoles spéciales, enfin l'Université de Bruxelles, sur un total de 1,311 étudiants en compte 139 fréquentant l'Ecole polytechnique. Sur un total de 4,835 étudiants fréquentant les cours des quatre Universités, 937 sont attachés à la faculté des sciences et 1,010 sont inscrits à la faculté technique de Liège et aux écoles spéciales.

Vous trouverez dans les rapports triennaux, dûs à la plume de l'éminent directeur général van Camp, enlevé si prématurément le 4 mai dernier à la direction de l'enseignement supérieur, des lettres et des sciences, sur l'état de l'enseignement supérieur des lettres et des sciences officiel et dans les archives du ministère de l'Intérieur et de l'Instruction Publique tous les renseignements sur les Universités belges et particuliérement sur les examens subis devant les facultés des quatre Universités du royaume et devant les jurys constitués par le Gouvernement pour l'obtention des grades académiques.

Parmi les moyens de favoriser les hautes études en Belgique il y a lieu de signaler les bourses accordées aux jeunes gens peu fortunés qui manifestent des aptitudes et de l'application au travail. Les associations des Anciens Etudiants des Universités de Louvain et de Bruxelles allouent également des bourses. Le Gouvernement confère chaque année, à la suite de concours, des bourses de voyage destinées à fournir aux lauréats le moyen de compléter leurs études pendant une année dans les universités de l'étranger.

Un Conseil de perfectionnement de l'enseignement supérieur est appelé à délibérer sur les questions les plus importantes qui intéressent la prospérité des études universitaires.

L'Académie royale des sciences, des lettres et des beaux-arts de Belgique, qui a son siège à Bruxelles et dont le Roi est le protecteur, est divisée en trois classes; ses travaux comportent la mise au concours de questions qui touchent de près au développement de l'enseignement technique et professionnel.

III.

A côté des universités et des écoles annexes, nous avons en Belgique plusieurs établissements qui doivent être rangés parmi ceux d'enseignement supérieur et qui ont particulièrement pour objet l'enseignement pratique et théorique:

Dans le domaine agricole, l'Institut de Gembloux; dans le domaine maritime, les Ecoles de navigation; dans le domaine militaire, les Ecoles de guerre; dans le domaine commercial, l'Institut supérieur de commerce d'Anvers; et dans le domaine artistique, les Académies royales des Beaux-Arts d'Anvers et de Bruxelles et les Conservatoires de Musique.

Je les passerai rapidement en revue.

Beaux-Arts. — L'Ecole des Beaux-Arts, fondée à Anvers en 1663, est administrée par le Gouvernement et le conseil communal sous le titre d'Académie royale des Beaux-Arts d'Anvers; elle est divisée en deux sections:— L'Institut Supérieur et l'Académie proprement dite. L'enseignement, gratuit à tous les degrés, se donne dans les deux sections pendant neuf mois consécutifs: du 1er octobre au 30 juin.

L'Institut comprend l'enseignement supérieur complet des arts graphiques et plastiques, tandis que l'Académie proprement dite donne surtout l'enseignement élémentaire des arts du dessin et l'enseignement moyen des arts graphiques et plastiques.

L'Académie royale des Beaux-Arts et l'Ecole des Arts décoratifs de Bruxelles donnent l'enseignement du dessin, de la peinture, de la sculpture, et de l'architecture dans toutes leurs applications ainsi que les sciences nécessaires à la culture de chacune de ces branches. L'enseignement de l'Académie est consacré à l'étude des beaux-arts; celui de l'Ecole des arts décoratifs, aux applications des arts plastiques à l'industrie.

Le Conservatoire de Bruxelles, fondé en 1832, qui a eu à sa tête l'illustre François Fétis, et possède aujourd'hui pour directeur l'éminent compositeur Gévaert est, sans contredit, la première école de musique du monde. C'est une vraie université musicale à laquelle est attachée un musée instrumental aussi remarquable que complet.

Le Conservatoire de Liège qui a pour directeur, M. Théodore Radoux, celui de Gand dirigé par Mons. Adolphé Samuel, l'Ecole flamande de musique à la tête de laquelle se trouve Pieter Benoit, l'un des compositeurs les plus richement doués, l'Académie de musique de Mons, l'Ecole de Louvain, le Conservatoire de Bruges possèdent un enseignement également renommé dans le monde musical.

Les Conservatoires royaux de Belgique comprenaient, au dermier recensement, la population suivante: Bruxelles 765 élèves dont 436 hommes et 329 femmes; Liège 736 élèves dont 498 hommes et 238 femmes; Gand 558 élèves dont 278 hommes et 280 femmes.

Indépendemment des Conservatoires royaux, il y a plus de 225 établissements d'instruction musicale et sur ce nombre 50, fréquentés par 11,571 élèves dont 6,645 hommes et 4,925 femmes, sont des institutions communales subventionnées par l'Etat et soumises à l'inspection du gouvernement.

Une des causes principales du développement artistique de la Belgique doit être assignée à l'organisation de l'enseignement des académies d'art, des conservatoires, des écoles de dessin: l'importance et la valeur artistique de plusieurs de nos institutions ne sont dépassées nulle part.

L'intervention des pouvoirs publics encourage la culture nationale du goût et les progrès dans le domaine de l'enseignement artistique de l'homme comme de la femme. Toutes les années ils organisent des solennités musicales, des expositions des beaux-arts et accordent de larges subsides aux expositions régionales et internationales où les élèves diplomés de nos institutions d'enseignement supérieur trouvent l'occasion de se distinguer.

Agriculture.—Le premier des établissements d'instruction agricole fondés aux frais de l'Etat et avec le concours du Gouvernement par une loi du 18 juillet 1865, est l'Institut Agricole de l'Etat établi à Gembloux, province de Namur.

L'enseignement donné à l'Institut est théorique et pratique.

L'enseignement théorique embrasse les cours suivants: génie rural, sciences physiques et chimiques, histoire naturelle, culture, silviculture, zootechnie, législation rurale et forestiére et droit constitutionnel, comptabilité agricole, économie politique, analyse microscopique. L'enseignement pratique comprend toutes les applications des cours qui précèdent dans une ferme d'une étendue de plus de 65 hectares, des jardins et des champs d'expériences et de démonstrations.

La Station agronomique et laboratoire d'analyses de l'Etat de Gembloux a pour but d'entreprendre des recherches de chimie et de physiologie végétale et animale appliquées à l'agriculture et d'exécuter les analyses.

Chaque année un jury procède à l'examen des élèves qui désirent obtenir le diplôme d'ingénieur agricole; des subsides spéciaux sont accordés aux candidats qui ont subi l'examen de sortie avec le plus de distinction, afin de leur permettre de compléter leurs études par des voyages à l'étranger.

Commerce.—Le programme du Congrès ayant une section spéciale pour l'instruction commerciale, je parlerai plus loin de l'Institut Supérieur de Commerce d'Anvers.

IV.

J'ai dit plus haut qu'aucun document officiel ne nous renseignait sur la situation spéciale de l'enseignement industriel et professionnel depuis plus de dix ans; la province de Hainaut publie chaque année un rapport fort complet et fort intéressant sur les progrès de son instruction technique durant l'exercice écoulé. Sans aucun doute ce travail fera partie des documents qui seront mis sous les yeux du Congrès par les délégués du Gouvernement belge. L'enseignement professionnel est donné dans la province de Hainaut dans 18 établissements dont 2 ont été créés en 1895. Six ou sept communes appartenant à quatre arrondissements se préparent à créer de nouvelles écoles; il y a done lieu de constater dans cette province qui compte actuellement les meilleures et les plus nombreuses écoles un fort mouvement en faveur de la diffusion de l'enseignement industriel.

La population scolaire de ces établissements suit une progression sans cesse ascendante: au premier janvier, 1896, le nombre des élèves était de 6,043, soit de 13 °/₀ supérieur à celui du premier janvier, 1895.

Les subsides accordés par l'Etat à l'enseignement industriel et professionnel sont, pour 1897, de 750,000 francs.

Ces écoles industrielles comprennent des cours théoriques de mathématiques et sciences, de langues modernes, des cours de dessin appliqué à l'industrie et des cours professionnels proprementdits.

Les provinces et les communes et plusieurs établissements industriels importants octroyent également des subsides à l'enseignement technique et professionnel.

Nous avons vu la place qui est donnée à l'étude des arts et des sciences dans l'enseignement supérieur. Nous aurions dû comprendre dans cette nomenclature l'Ecole provinciale et des mines du Hainaut établie à Mons en exécution de la résolution du conseil provincial du 13 juillet, 1837, dirigée actuellement par M. le professeur A. Macquet. La preuve en sera mise sous vos yeux par la nomenclature des cours qui sont donnés dans cette école qui fait honneur à la Belgique: Physique industrielle; électricité; electrotechnique; minéralogie et géologie; économie politique; exploitation des chemins de fer; constructions des machines; construction des chemins de fer, routes; exploitation des mines; dessin industriel; géométrie descriptive; charpente et stéréotomie; topographie; métallurgie; chimie industrielle minérale; chimie minérale; docimasie et chimie analytique, droit public et industriel, législation des mines; chimie organique, élémentaire et expérimentale; chimie organique; algèbre, géometrie analytique, calcul différentiel et intégral; mécanique élémentaire; mécanique appliquée et thermodynamique; constructions civiles et résistances des matériaux; physique expérimentale; dessin géométrique et industriel.

Voici, par province, la nomenclature des écoles industrielles:

Province d'Anvers. — Ecole industrielle d'Anvers, organisée par arrêté ministériel du 14 novembre, 1866. Ecole professionnelle pour jeunes filles à Anvers, organisée par arrêté ministériel du 30 avril, 1880.

Province de Brabant.—Ecole de dessin et école industrielle réunies, Anderlecht; Ecole professionnelle et ménagère à Braine-L'Alleux; Ecole industrielle à Bruxelles, organisée en suite de la convention du 28 juin, 1886, entre l'Etat et la ville de Bruxelles; Ecole professionnelle d'art appliqué à la bijouterie et à la ciselure, Palais du Midi, Bruxelles; Ecole nationale d'horlogerie; Ecole professionnelle de tailleurs, à Bruxelles; Ecole professionnelle de tapissiers-garnisseurs, à Bruxelles; Ecole professionnelle de typographie, à Bruxelles; Ecole professionnelle pour jeunes filles, à Bruxelles; Ecoles professionnelles et ménagères à Bruxelles; Ecole professionnelle pour jeunes filles à Bruxelles; Ecole ménagère et professionnelle à Heverlé (Louvain); Ecole professionnelle à Ixelles; Ecole professionnelle des minimes, à Louvain; Ecole professionnelle de St. Pierre à Louvain; Ecole industrielle à Louvain; Ecole industrielle à Nivelles; Ecole professionnelle de St. Gilles; Ecole professionnelle ménagère communale à St. Gilles; Cours professionnels pour jeunes filles à St. Josse-ten-Noode; Ecole de Saint-Luc à Schaerbeek; Ecole professionnelle pour jeunes filles à Schaerbeek; Ecole de dessin et d'industrie à Schaerbeek; Ecole professionnelle et ménagère communale à Schaerbeek; Ecole professionnelle d'Uccle; Ecole de dessin et industrielle réunies de Vilvorde.

Province de Flandre occidentale.—Ecole professionnelle de pêche à Blankenberghe; Ecole industrielle et académie de dessin y annexée, à Courtrai; Ecole industrielle de Furnes; Ecole professionnelle de pêche à Nieuport; Ecole industrielle à Ostende; Ecole professionnelle de pêche à Ostende; Ecole industrielle à Ypres.

Province de Flandre orientale.—Ecole professionnelle de peinture décorative d'Audenaerde; Institut Supérieur de brasserie, à Gand; Ecole technique de Brasserie, à Gand; Ecole industrielle, à Gand; Ecole professionnelle de garçons, à Gand; Ecole professionnelle de jeunes filles, à Gand; Ecole Saint-Luc, à Gand; Ecole professionnelle de jeunes filles à Grammont; Ecole professionnelle des frères de N.-D. de Lourdes, à Oostacker; Ecole industrielle de Saint Nicolas.

Province de Hainaut.—Ecole industrielle, à Ath; Ecole professionnelle et ménagère à Ath; Ecole industrielle à Boussu; Ecole industrielle, à Charleroi; Ecole industrielle, commerciale, et de dessin de Chatelet; Ecole industrielle de Dour; Ateliers d'apprentissage pour la taille des pierres, à Ecaussinnes-Enghien; Ecole industrielle de Fontaine-L'Evèque; Ecole industrielle de Gosselies; Ecole industrielle à Houdeng-Aimeries; Ecole industrielle de Jemappes; Ecole industrielle, à Jumet; Ecole industrielle de La Louvière; Ecole de brasserie de La Louvière; Ecole industrielle à Marchienne-au-pont; Ecole professionnelle de jeunes filles, à Mons; Ecole industrielle à Morlanvelz; Ecole industrielle à Pâturages; Ecole industrielle, à St. Ghislain; Ecole industrielle à Soignies; Ecole industrielle à Tournai; Ecole professionnelle St. Luc, à Tournai; Ecole ménagère professionnelle de Tournai.

Province de Liége.—Ecole sucrière à Glons; Ecole de dessin industriel, à Herve; Ecole industrielle, à Huy; Ecole industrielle, à Liége; Ecole professionnelle de St. Luc, à Liége; Ecole professionnelle de tailleurs, à Liége; Ecole professionnelle d'armurerie à Liége; Ecole industrielle, à Seraing; Ecole Supérieure des textiles et école professionnelle à Verviers; Ecole professionnelle pour jeunes filles, à Verviers.

Province de Limbourg. — Académie de dessin et école industrielle, à Hasselt.

Province de Luxembourg.—Académie des beaux-arts et école industrielle, à Arlon.

Province de Namur.—Ecole industrielle, à Namur; Ecole industrielle, à Tamines; Ecole industrielle, à Walcourt.

Les ateliers d'apprentissage sont au nombre de 32: 22 dans la Flandre occidentale; 8 dans la Flandre orientale; 1 dans la province de Limbourg; et 1 dans la province de Namur.

On fabrique dans ces établissements des tissus unis, ouvrés, façonnés et damassés en coton, lin, chanvre, jute, laine peignée et cardée, soie, etc. . . . . . . purs et mélangés, tels que: cotonnettes et coutils en tous genres, étoffes pour robes, pantalons, ameublements, draps divers, châles, couvertures, piqués, velours, tapis, etc.

Les écoles et classes ménagères subsidiées par l'Etat sont au nombre de 219; ces institutions se répartissent comme suit: Anvers 15; Brabant 28; Flandre occidentale 15; Flandre orientale 41; Hainaut 46; Liége 34; Limbourg 12; Luxembourg 10; Namur 8.

L'enseignement maritime se donne dans deux écoles de Navigation de l'Etat, l'une à Anvers, l'autre à Ostende; l'enseignement y est gratuit. Les leçons se donnent du 1er septembre au 31 juillet, les dimanches et fêtes exceptés. L'enseignement comprend les matières suivantes: arithmétique, géométrie, trigonométrie, astronomie nautique, navigation, gréement, arrimage, manœuvres, machines à vapeur marines, etc.; le commerce appliqué à la navigation marchande; observations météorologiques à la mer, d'après le système adopté par la conférence maritime tenue à Bruxelles en 1853; connaissance de la langue anglaise; rédaction des actes de l'état civil à bord d'un navire à la mer, etc.

Indépendamment de concours annuels entre les élèves de chaque école, des examens ont lieu pour les personnes qui se destinent à la navigation. Les examens sont confiés à un jury spécial pour chaque école, et composé de trois membres y compris le président.

Les concurrents qui satisfont aux conditions des programmes établis à cet effet, et qui ont le nombre requis d'années de navigation, obtiennent un certificat de capacité pour le grade de capitaine, de premier ou de second lieutenant au long cours, de capitaine ou de lieutenant au cabotage, et de patron-pêcheur.

Il existe un cours élémentaire de navigation à Nieuport pour les pêcheurs.

Les écoles de navigation d'Anvers et d'Ostende comprennent un cours spécial de machines à vapeur marines, donné par des fonctionnaires du service des constructions maritimes et placé sous la surveillance des conseils d'administration des deux écoles. Un jury spécial se réunit périodiquement, sous la présidence de M. l'ingénieur Lecointe, à Anvers et à Ostende à l'effet de procéder à l'examen des candidats qui désirent obtenir le diplôme de mécanicien de bateau à vapeur institué par l'arrêté royal du 12 novembre, 1888.

Les Athénées royaux donnent une importance très grande à l'enseignement du dessin, mais il est à regretter, avec M. Louis de Taye, inspecteur de l'enseignement des arts du dessin, que l'enseignement supérieur et moyen ne comprenne pas l'étude sommaire de l'esthétique, car l'enseignement de la philosophie du beau, comme celui des principes de l'économie politique et sociale, devrait être organisé partout et surtout dans les établissements qui ont pour mission d'enseigner l'art industriel et la science commerciale, la véritable éducation technique de tous ceux qui veulent parvenir par le travail.

Dans une brochure de M. E. Rombaut (La Belgique industrielle—Enseignement industriel et professionnel), une définition nette et précise, mais trop catégorique, est donnée de la mission de ces écoles:—"l'Enseignement industriel, dit-il, ne s'occupe que de la propagation de la "science," mais il ne faut voir dans ce mot science que l'application directe et élémentaire des connaissances nécessaires aux diverses industries." Je pense avec M. de Taye que la science et l'art doivent marcher de front pour créer des artisans habiles, des commis instruits et des contremaîtres intelligents.

Sans aucun doute le Congrès étudiera la question d'organisation des écoles industrielles et des écoles professionnelles. Il est à désirer qu'il formule un programme complet d'enseignement technique.

Des hommes d'initiative ont institué en Belgique, dans les grands centres industriels du pays, des cours destinés à relever le niveau intellectuel et l'éducation technique de nos travailleurs. L'enseignement industriel donné dans ces conférences est confié à des professeurs de talent et leurs cours sont entièrement gratuits.

Le programme du Congrès ayant exclu de ses travaux l'enseignement primaire, je crois ne pas devoir aborder les multiples questions se rattachant à la matière; je me permettrai toutefois d'exprimer le vœu que l'enseignement du dessin commence dès l'école primaire

Le Comte Adrien d'Oultrement dans son rapport sur les écoles professionnelles présenté à la troisième section de la commission du travail instituée par arrêté royal du 15 avril 1886, exprimait avec raison cette opinion que le dessin est indispensable à l'ouvrier; le dessin, cette écriture de l'industrie, disait M. Duruy, qui "donne de l'exactitude au coup-d'œil de l'enfant, de la souplesse et de l'habileté à sa main, en même temps qu'il forme son goût et développe en lui le sentiment du beau."

M. d'Oultrement ajoutait dans ce rapport où il parle de l'œuvre des écoles professionnelles qui s'est fondée en Belgique à la fin de 1885:—"L'étude du dessin en général doit être considérée comme faisant partie essentielle de l'enseignement primaire, mais aussitôt que l'apprenti est initié aux notions générales, il faut qu'il apprenne à appliquer les connaissances du dessin à la branche d'industrie à laquelle il doit appliquer son talent et consacrer sa vie."

Rien ne peut mieux aider à développer les connaissances techniques si nécessaires à ceux auxquels sont confiés les progrès de l'industrie privée : ouvriers, contremaîtres, chefs d'industrie.

En résumé, on ne peut trop faire de sacrifices pour donner à l'ouvrier l'enseignement professionnel, au contremaître l'enseignement industriel, au chef d'industrie l'instruction supérieure.

V.

Enseignement Commercial.

L'un des plus grands établissements d'instruction commerciale du monde est l' *Institut Supérieur de Commerce d'Anvers*.

C'est à M. A. Dechamps, Ministre des Affaires Etrangères que revient l'honneur d'avoir, en 1847, sur la proposition de M. H. Matheyssen, saisi le conseil communal et le conseil provincial siégeant en cette ville d'un projet de créer dans notre métropole commerciale "une Université belge du Commerce et de l'Industrie."

Les universitaires et le monde officiel ne purent admettre qu'on voulût placer sur la même ligne l'enseignement commercial et les humanités. Le titre d'Institut remplaça donc celui d'Université et la création de l'école fut l'objet non d'une loi mais d'un simple arrêté ministériel; ce qui plaçait l'Institut dans une situation inférieure aux écoles normales, aux universités, aux athénées, et aux écoles moyennes du royaume et devait couper court pour longtemps à son essor.

L'idée de fonder une école de commerce était abandonnée quand en 1852 M. Rogier, Ministre de l'Intérieur, fixa les bases de l'organisation de la nouvelle école et les soumit au conseil communal qui s'empressa de voter à l'unanimité l'arrêté qui autorisait la ville à ratifier la proposition du ministre.

Quelques jours après un arrêté, contresigné du roi, créait l'Institut qui ouvrait ses portes en 1853 avec cinquante-et-un élèves dont dix réguliers et quarante-et-un spéciaux.

Quatorze ans après sa fondation, en 1897, l'Institut ne comptait encore que soixante-six élèves dont trente-cinq étrangers, ce qui montre que sa réputation, très méritée déjá était mieux établie au delà de nos frontières qu'en Belgique même.

C'est seulement depuis que le titre de "Licencié en sciences commerciales" a été conféré, en 1876, aux élèves de l'Institut qui ayant terminé leurs études et subi les examens prescrits, obtiennent un diplôme de capacité et lorsque M. Grandgaignage a été appelé à diriger cet important établissement que le nombre des élèves réguliers s'est élévé d'année en année.

L'abaissement du prix d'inscription au rôle de l'Institut ainsi que les dispositions prises par l'Etat en faveur du diplôme, assimilé à la licence, et placé dans la loi électorale de 1883 sur le pied d'égalité avec les diplômes universitaires et l'arrêté royal du 16 octobre, 1878, créant des bourses d'étude en faveur de l'enseignement commercial et des bourses de voyage en faveur des licenciés en sciences commerciales, a aussi fortement contribué au succès de cet établissement modèle.

Le nombre des élèves belges et des élèves réguliers, c'est-à-dire suivant tous les cours et soumis à des examens permanents et aux examens de fin d'année, va grandissant de période en période quinquennale comme vous le verrez dans le tableau suivant :—

Années.	Total.	Belges	Etrangers.	Réguliers.	Spéciaux.
1853 à 1857	316	226	90	124	192
1858 ,, 1862	348	157	191	206	142
1863 ,, 1867	358	164	194	183	175
1868 ,, 1872	571	342	229	221	350
1873 ,, 1877	666	372	294	247	419
1878 ,, 1882	637	410	227	276	361
1883 ,, 1887	683	402	281	408	275
1888 ,, 1892	945	539	406	628	317
1893 ,, 1896	906	569	337	636	250
	5,430	3,181	2,249	2,949	2,481

Quoique le nombre des élèves réguliers soit de 2,949, il n'a encore été délivré que 638 diplômes de capacité.

Ce nombre très restreint d'élèves réguliers parvenant à obtenir le diplôme de licencié en sciences commerciales a pour cause le manque de préparation aux études commerciales, le manque d'assiduité aux cours et pour le plus grand nombre, dans l'examen oral, des difficultés d'élocution.

L'Institut a pour but exclusif l'enseignement des sciences commerciales théoriques et appliquées.

L'enseignement complet s'était donné jusqu'en 1897 en deux ans et l'emploi du temps par semaine était ainsi divisé :—

Facultés.	Premiére année.	Seconde année.
Bureau commercial	12	12
Arithmétique commerciale	3	3
Histoire des produits commerciaux et chimie commerciale	2	3
Economie politique et statistique	1	2
Histoire générale du commerce	2	..
Géographie commerciale et industrielle	1	3
Droit commercial et maritime. Principes du droit des gens	2	..
Principes généraux du droit	..	1
Législation douanière	1	..
Construction et armements maritimes	..	1
Néerlandais	2	2
Allemand	3	3
Anglais	3	3
Espagnol ou Italien	3	3
Russe	..	3
Total des heures par semaine	35	39

Le bureau commercial qui figure pour 12 heures par semaine dans le tableau ci-dessus est annexé à l'Institut pour traiter fictivement les affaires de commerce et de banque d'une manière pratique; les exercices pratiques de commerce et d'industrie simulés comportent également deux années d'étude.

Voici l'ordre des matières du programme de l'Institut pour le bureau de première année :

A. Arithmétique commerciale. Répétition des opérations fondamentales, fractions ordinaires et décimales, parties aliquotes, proportions, explication des règles d'intérêt, d'escompte, de sociétés, de mélange, d'alliage, etc. Echéance moyenne. Comptes courants et d'intérêts (méthode directe, indirecte et hambourgeoise). Comptes de revient. Changes. Fonds publics, matières d'or et d'argent. Négociations, arbitrages en ces valeurs diverses.

B. Opérations simulées d'une maison de commerce traitant toute espèce d'affaires (la banque, les marchandises, les armements), pour propre compte, en commission, en participation. Applications des calculs commerciaux et de la comptabilité, factures, comptes d'achat et de vente, comptes de frais, comptes courants, comptes de revient de marchandises, etc. Opérations en changes, arbitrages, fonds publics. Inscription de chaque opération dans les livres régulièrement et pratiquement tenus en partie double. Lettres de change, effets à créer, à endosser, contrat d'association, lettre de voiture, connaissements, charte-parties, lettres à la grosse, warrants, contrats d'assurance, comptes de recouvrements et avaries particulières, règlements d'avaries grosses, etc. Usages de la place d'Anvers et des principales places étrangères, comparaison de poids, mesures, etc.

Correspondance en français, en néerlandais, en anglais et en allemand, ayant pour objet des ordres donnés ou reçus, l'achat et la vente de marchandises, la consignation de navires et leur chargement.

Bilan et liquidation de la maison à la fin de l'année.

Les élèves sont d'abord exerçés à la pratique du calcul des factures, des bordereaux de banque et de bourse, des comptes courants et de revient, des changes, des arbitrages, etc. ; ainsi qu'à la confection des lettres de change, des connaissements, charte-parties, lettres de voiture, etc. Chaque document commercial placé sous les yeux de l'élève est l'objet d'explications ou de renvois aux explications des cours théoriques.

Ensuite on aborde les opérations régulières d'une maison de commerce, la même pour tous les élèves et dans laquelle chacun d'eux doit remplir toutes les fonctions, tenir tous les livres et faire la correspondance relative aux opérations de la maison, en français d'abord et pendant les derniers mois de l'année, dans les diverses langues. Les opérations de ce commerce fictif sont dictées à l'élève en tenant compte des fluctuations des cours sur les divers marchés.

Chaque mois on fait la balance des opérations, et le 31 mai l'inventaire et l'ouverture des livres à nouveau sont dressés de manière que l'élève embrasse tout l'ensemble des opérations et des écritures.

Dans cette première année les affaires sont limitées à l'Europe, mais comprennent les affaires de commission et de banque, pour compte propre, en participation ou pour compte d'autrui ; les consignations et les affrètements, les expéditions.

Les comptabilités industrielles ou de sociétés sont appliquées dans les points ou elles diffèrent de la comptabilité commerciale ou de banque.

Dans le bureau de deuxième année, le plan change : l'élève exercé précédemment à traiter dans leur ordre de dates les opérations pouvant se liquider rapidement avec l'Europe, est maintenant exercé à suivre les opérations de longue haleine, depuis la transmission de l'ordre jusqu'à l'exécution parfaite, en passant par toutes les phases intermédiaires, pour aboutir à la vente sous voile ou sur un marché quelconque, tous calculs faits, toute correspondance en règle, toutes écritures passées dans l'ordre des combinaisons et du temps.

La marche générale de l'opération est seulement indiquée à l'élève, avec les conditions spéciales; c'est à lui de l'exécuter, au mieux de ses intérêts sous l'œil du professeur.

Ces opérations fictives, calquées sur des opérations réelles puisées dans la pratique des grandes maisons, sont poursuivies avec les principales places de commerce du monde. L'élève les suit aisément et avec intérêt car elles sont peu nombreuses.

Il en établit les divers comptes dans les poids, mesures et monnaies des divers pays ; il fait la correspondance dans les diverses langues.

On trouve dans ces exercices pratiques un excellent thème des connaissances acquises au bureau de première année ainsi que dans les différents cours théoriques.

Cette méthode est évidemment propre à former des négociants capables de comprendre l'ensemble des affaires, de les combiner et de les exécuter dans toutes leurs parties.

Rappelons que de prime abord l'Institut d'Anvers avait appliqué le système des sections ou maisons de commerce par lesquelles les élèves passaient successivement.

Importé à Mulhouse par M. le docteur Penot, ce système qui présente certains avantages, n'a pas réussi à l'école de Lyon. Il est encore en usage aux écoles de Marseille, de Bordeaux et du Havre.

Les raisons qui l'ont fait rejeter à l'Institut d'Anvers sont, dit Mons. Leautey—

1. Que les élèves ne faisaient ainsi qu'une partie du travail ;

2. Que les opérations étaient limitées avec quelques places parce qu'il était impossible de modifier continuellement les sections ;

3. Que les élèves occupaient l'un vis-à-vis de l'autre des positions inférieures qui n'étaient pas toujours acceptées avec plaisir ;

4. Qu'il fallait,pour appliquer parfaitement ce systéme, ou des chefs de bureau assez nombreux pour surveiller de près les opérations de chaque comptoir, ou des élèves moniteurs censément placés à la tête de ces comptoirs et capables d'exécuter les données du chef de bureau.

On a donc jugé préférable de faire exécuter par chaque élève toutes les parties des opérations en se transportant fictivement dans les places ou se passe chacune d'elles.

On est ainsi revenu à la méthode suivie dès 1820 à l'Ecole supérieure de commerce de Paris, qui, d'ailleurs, essaya, elle aussi, sous la direction de Blanqui, du sectionnement du bureau commercial par maisons de commerce et qui y renonça au bout de quelques années.

Voici l'ordre des matières du programme actuel de l'Institut pour le bureau commercial de deuxième année :

Complément de l'étude des conditions de vente et d'achat et des usages en général des places de commerce des diverses parties du monde.

Affaires d'importation, d'exportation, de transit, de commission, d'armement, d'assurance, de banque, etc. Application des calculs aux arbitrages.

Livres à tenir, comptes à faire, opérations de bourse, renseignements à recevoir ou à donner, contrats à terme.

Application à des questions pratiques des notions théoriques acquises dans tous les autres cours.

Questions contentieuses, opérations pratiques et comptabilité.

Rapports commerciaux, économiques, financiers et industriels à faire sur divers pays.

Correspondance en français, en néerlandais, en anglais, en allemand, en espagnol, en italien et en russe.

Avis commerciaux.—Outre les renseignements de la bourse d'Anvers, le Bureau commercial de l'Institut reçoit des avis réguliers de commerce de Londres, Liverpool, New York, La Havane, Rio-de-Janeiro, Buenos-Ayres, Valparaiso, Sydney, des Indes, de la Chine, d'Odessa, Hambourg, Amsterdam, du Havre, etc.

Tous ces renseignements en langue originale sont communiqués aux élèves.

Arithmétique commerciale. Questions d'intérêts composés, de placements annuels, d'annuités ; applications nombreuses aux questions d'emprunts, d'amortissements, de rentes viagères, etc. ; crédits fonciers, obligations, emprunts à prime, assurances; principes pour le calcul des primes ; assurances maritimes contre l'incendie et sur la vie ; tables de mortalité, assurances dotales, tontines, chemins de fer, tarifs, dépenses de l'unité de trafic, etc.

Un cours préparatoire comprenant les matières de l'examen d'admission au cours de première année existe à l'Institut ; cette école spéciale, annexe, est ouverte de Pâques au 10 août ; elle a été créée surtout pour faciliter l'examen d'entrée des étrangers.

Le minimum d'âge d'admission est seize ans six mois.

Le programme du cours préparatoire et de l'examen d'admission en première année comprend :

I.—Cours de langues (langue française, langue allemande, langue anglaise).

II.—Tenue des livres.
III.—Géographie.
IV.—Mathématiques.
V.—Notions élémentaires de physique et de chimie.
VI.—Histoire universelle.
VII.—Droit commercial.
VIII.—Economie politique.

Les examens d'admission ont lieu par écrit et oralement sur les matières énoncées cidessus.

La partie théorique du cours de première année comprend ce qui suit :

I.—Histoire des produits commerciaux ; cours donné sur les échantillons du musée annexé à l'Institut (produits du règne minéral et du règne végétal).
II.—Géographie commerciale et industrielle.
III.—Principes généraux de droit.
IV.—Economie politique.
V.—Allemand.
VI.—Anglais.
VII.—Neérlandais.
VIII.—Espagnol ou Italien.

La partie théorique comprend pour la deuxième année les cours suivants :

I.—Histoire des produits commerciaux et chimie commerciale (produits du règne végétal, suite, produits tirés du règne animal, et produits fabriqués). Les élèves sont initiés aux opérations de chimie commerciale dans un laboratoire annexé à l'établissement.
II.—Histoire générale du commerce et de l'industrie.
III.—Géographie commerciale et industrielle.
IV.—Droit commercial et maritime. Principes du droit des gens.
V.—Législation douanière.
VI.—Construction et armements maritimes.
VII.—Economie politique.
VIII.—Allemand.
IX.—Anglais.
X.—Néerlandais.
XI.—Espagnol ou Italien.
XII.—Russe.

VI.

Le Comité central de la Chambre de Commerce d'Anvers avait, sur la proposition de M. Alexandre Frank, soumis la question de l'enseignement commercial à une commission, présidée par M. Louis Strauss, président du conseil supérieur du Commerce et de l'Industrie et président du cercle des anciens étudiants de l'Institut Supérieur de Commerce d'Anvers.

Cette commission, composée de MM. A. Bulcke, F. Déjardin, A. Frank, et L. Van Peborgh, a nommé M. A. Frank son secrétaire rapporteur.

Ce rapport affirme que le commerce est devenue une science exacte dont la connaissance exige des études multiples, embrassant à la fois la production, la consommation, l'industrie et ses transformations, la statistique, la situation économique et financière ainsi que les évènements et les éléments de nature à les modifier, la question du crédit, le droit commercial et tant d'autres auxiliaires indispensables aux affaires, tels que les banques, les assurances, les armements, les affrètements, le transport, la commission, etc.

Cet intéressant rapport, qui semble avoir été préparé pour le Congrès International de l'Enseignement Technique et que vous trouverez ci-annexé dans le numéro du 13 mai de la "Revue Economique," demande l'organisation de l'enseignement commercial graduel et méthodique. Celui-ci doit avoir la place importante qui lui revient et qui donnera au commerçant belge dans la vie sociale, le rang qu'il occupe dans les pays anglo-saxons.

Le rapport, en traitant de l'enseignement supérieur, demande la subdivision des hautes écoles en deux degrés ; le premier comprenant les deux années d'étude conduisant au titre de "Licencié en Sciences Commerciales ;" le second donnant, après une troisième année d'étude, l'occasion d'acquérir le titre de "Docteur en Sciences Commerciales," qui leur permettrait de se vouer aux carrières diplomatique et consulaire.

Les élèves de l'Institut d'Anvers ont l'usage d'une bibliothéque où se trouvent tous les ouvrages, les journaux et les publications se rapportant aux sciences commerciales et économiques, aux rapports consulaires des différents pays, aux voyages, etc.

La ville d'Anvers a organisé un Musée Commercial à l'instar de celui de Bruxelles établi dans la capitale sous la direction de l'administration centrale du Département des Affaires Etrangères.

Le Ministre qui dirige notre Foreign Office est, en Belgique, aussi notre Ministre du Commerce.

Le musée commercial de Bruxelles qui est ouvert tous les jours au public a pour but de renseigner nos travailleurs sur la marche des affaires dans les pays étrangers et de leur faciliter en même temps les transactions commerciales avec les consommateurs et les producteurs de ces contrées ; il prend, dans le domaine des sciences commerciales, la place qu'occupent dans le domaine des sciences naturelles les collections minéralogiques, géologiques, et anatomiques. C'est en quelque sorte un complément de l'enseignement technique commercial, car à côté des produits, le visiteur trouve dans la bibliothéque du musée non-seulement des traités techniques se rapportant aux principales industries mais toutes les publications du monde traitant des questions industrielles, économiques, financières et commerciales.

Des conférences et des visites dans les principales usines du pays sont organisées par les soins de l'administration de l'Institut Supérieur et complètent son enseignement.

Toutes ces questions d'enseignement supérieur commercial ont été résolues à la direction de l'enseignement supérieur des sciences et des lettres par MM. de Favereau et Schollaert, Ministres des Affaires Etrangères et de l'Intérieur conjointement avec leurs collègues de l'Agriculture et de l'Industrie, MM. de Bruyn et Nyssens.

C'est à Son Excellence le Baron de Favereau que revient l'honneur d'avoir assuré l'organisation définitive de l'enseignement commercial supérieur en Belgique en contresignant l'arrêté royal du 13 février 1897.

Désormais, pour obtenir le titre de vice-consul de carrière, il est nécessaire, indépendamment des conditions exigées de tout belge pour devenir fonctionnaire, de produire certaines preuves d'aptitude. Ces preuves peuvent résulter de la possession du diplôme de licencié du degré supérieur en sciences commerciales et consulaires délivré, dans certaines conditions, par les Universités belges ou par l'Institut d'Anvers.

Voilà donc l'enseignement supérieur des sciences commerciales et consulaires en vigueur non-seulement à l'Institut d'Anvers, mais dans les Universités du Royaume, à l'Ecole militaire, à l'Institut Agricole de Gembloux et à l'Ecole provinciale des mines du Hainaut.

Vous trouverez, en annexe, le programme officiel des cours de troisième année de l'Institut Supérieur de Commerce d'Anvers inauguré récemment.

"L'Article I. de l'arrêté du 13 janvier 1897, réglant les examens consulaires stipule, dit M. de Ramaix, rapporteur du budget des Affaires Etrangères dans son rapport fait au nom de la section centrale à la Chambre des Représentants de Belgique, 'que les porteurs de diplômes de licencié du degré supérieur en sciences commerciales et consulaires délivrés soit par l'Institut Supérieur de Commerce d'Anvers, soit par les Universités, pourront seuls être admis aux fonctions consulaires sans avoir à subir d'examen nouveau.'

Il nous a paru intéressant de nous informer de l'accueil réservé à ces dispositions par notre jeunesse universitaire et notamment de rechercher si le nouveau cours créé dans ce but, en novembre dernier, à l'Institut d'Anvers, était fréquenté.

Naturellement les renseignements nous manquent au sujet des Universités, puisque l'arrêté n'a pas encore pu être appliqué; mais nous savons que quinze élèves, y compris deux étrangers, suivent en ce moment, à Anvers, le cours en question.

Le programme de cette troisième année d'études imposé aux licenciés en sciences commerciales qui se destinent à la carrière consulaire et la haute valeur des professeurs préposés à cet enseignement permettent d'espérer dans l'avenir, plus encore que par le passé, que le Gouvernement trouvera parmi les élèves de l'Institut Supérieur de Commerce une pépinière de jeunes gens à la hauteur de leurs fonctions et à même de rendre d'utiles et de réels services au pays.

Il ne sera pas hors de propos de rappeler que ce même Institut a déjà fourni au corps consulaire belge trente membres dont plusieurs comptent parmi nos meilleurs agents et dont quelques-uns ont acquis, dans le pays et à l'étranger, des situations absolument prépondérantes. D'autre part, soixante-huit de ces anciens élèves ont obtenu des bourses de voyage conférées par le Gouvernement.

Tout nous permet donc d'espérer de l'organisation nouvelle des résultats sérieux et favorables au recrutement des jeunes consuls."

Le Ministère des Affaires Etrangères de Belgique a lieu de se féliciter des innovations sérieuses qu'il vient d'introduire dans sa représentation consulaire et au concours qu'il a apporté à l'organisation de l'enseignement commercial supérieur, enseignement qui relèvera le prestige de la carrière commerciale.

Les sections professionnelles de nos athénées et quelques institutions privées, laïques ou religieuses, seules, donnent de l'importance à l'enseignement commercial et économique.

Maintenant que nous possédons une université commerciale, nous ne tarderons pas à suivre, en Belgique, l'exemple de la Chambre de Commerce de Londres et nous ouvrirons, dans nos établissements d'enseignement primaire et moyen, des cours qui feront comprendre l'importance capitale de l'instruction commerciale surtout dans les pays de production industrielle.

VII.

ENSEIGNEMENT PRIMAIRE ET MOYEN.—RÉSUMÉ.

Les renseignements qui précèdent doivent être complétés par un résumé concernant l'enseignement primaire et moyen.

A.—Enseignement Technique.

Les écoles techniques inférieures belges sont divisées en deux types différents :

1. Ecoles industrielles.
2. Ecoles professionnelles.

Dans les premières on ne donne que des cours du soir et du dimanche et les élèves sont des ouvriers ou employés occupés à l'atelier pendant le jour.

Dans les secondes les élèves sont tenus à l'école tout le jour et y travaillent manuellement.

A un autre point de vue il existe des écoles communales et des écoles libres.

Les premières sont administrées par une commission où les délégués de la commune forment la majorité.

Dans les secondes, la commune est simplement représentée par un ou plusieurs délégués pour contrôle de l'emploi des subsides accordés, et l'administration de l'école appartient à des délégués des métiers ou syndicats qui l'ont créée.

L'Etat, la province, la commune, et des particuliers interviennent dans les dépenses.

L'Etat accorde généralement un tiers de la dépense, déduction faite du loyer et du minerval, aux écoles industrielles et deux tiers aux écoles professionnelles qui coûtent beaucoup plus cher.

Charleroi, Liège, Morlanvelz, etc.—ont des écoles industrielles pures.

Bruxelles fait exception momentanément au point de vue des subsides parce que l'Etat l'a chargée de deux services anciens du Musée Royal de l'Industrie supprimé en 1886.

Les Ecoles d'horlogerie, des tailleurs sont des écoles professionnelles libres pures.

L'Ecole Nicaise (mécanique) à Gand est une école professionnelle communale pure.

Tournai, anciennement école des arts et métiers est une école communale à la fois professionnelle et industrielle. Les élèves sont envoyés dans un atelier particulier où ils travaillent sous la surveillance de contremaîtres placés par la commune.

Les programmes d'études sont excessivement variables d'un point à un autre du pays, mais tous ont une base commune.

On enseigne à tous les élèves pendant les premières années, dans toutes les écoles, le dessin, les mathématiques, la géométrie, les éléments de physique et de mécanique, l'hygiène et l'économie industrielle.

Chaque école a des cours d'application appropriés à l'industrie de la localité et là encore le dessin marche de pair avec la technologie.

Exemple :—Charleroi a la métallurgie ;
Morlanvelz, l'exploitation des mines ;
Soignies, la coupe des pierres ;
Ostende, la pêche ;
Anvers, les constructions navales ;
Gand, le tissage ;
Bassenge, le tressage de la paille ;
et ainsi de suite.

Le Gouvernement belge subsidie aussi une cinquantaine d'écoles qui renferment plus de trente mille élèves, et la dépense totale de ces écoles, non compris les frais de premier établissement, s'élève à une cinquantaine de francs par élève.

Je terminerai ce résumé en mettant sous vos yeux le texte des conclusions adoptées par la commission du travail instituée par arrêté royal du 15 avril, 1886, dans sa séance plénière du 5 févier, 1887, M. le Comte d'Oultrement remplissant les fonctions de rapporteur.

I.

Il y a lieu, pour les pouvoirs publics, d'encourager la création d'écoles professionnelles en annexant aux académies et aux écoles industrielles des cours d'art et de science appliqués à l'industrie.

Cet enseignement devrait avoir une direction pratique.

L'initiative privée qui s'affirme par la création d'écoles professionnelles et d'apprentissage pourrait être encouragée par les pouvoirs publics si au surplus, ces écoles répondent à toutes les conditions de publicité et d'inspection.

II.

La culture de l'habileté manuelle doit commencer à l'école primaire.

Les applications théoriques des sciences à l'industrie s'enseignent à l'école industrielle.

Les applications théoriques des arts graphiques et plastiques à l'industrie s'enseignent dans les écoles d'art décoratif.

L'apprentissage se fait dans les ateliers ou dans des écoles fondées par des patrons ou des syndicats professionnels et intimement unies à des ateliers.

III.

L'action de l'Etat doit se borner à établir une harmonie et une gradation entre ces diverses écoles d'enseignement professionnel, à les encourager par des subsides tout en respectant, le plus possible, l'initiative propre des groupes qui les ont fondées.

IV.

Les communes pourront prêter leur concours à l'enseignement professionnel par

1. L'introduction d'exercices manuels dans les écoles primaires ;
2. La fondation d'écoles industrielles et d'écoles de dessin et de modelage ;
3. Des encouragements consistant en subsides par l'octroi des locaux aux syndicats professionnels.

V.

L'Etat et les communes devraient subordonner leur concours aux conditions suivantes :

1. Un minimum d'âge pour l'admission à l'école d'apprentissage ;
2. Un minimum de connaissances, justifié par un examen, pour l'admission des apprentis.

Ce minimum pourrait être une connaissance complète de la lecture, de l'écriture et des quatre règles fondamentales de l'arithmétique.

VI.

Le Gouvernement devrait favoriser la création de cours supérieurs d'adultes dans lesquels serait donné un enseignement théorique approprié aux besoins des ouvriers dans la grande industrie.

VII.

Le Gouvernement est invité à étendre, aux enfants d'ouvriers fréquentant une école technique, le tarif des abonnements ouvriers au chemin de fer.

La collectivité des écoles industrielles, professionnelles et commerciales de Belgique expose, à l'exhibition internationale de Bruxelles, près de la section britannique, une très intéressante collection de produits qui permet de constater les résultats de notre enseignement technique et commercial.

La commission organisatrice de ce compartiment est composée d'un président, M. Rombaut, délégué du Gouvernement belge au Congrès et de deux secrétaires : M. Wauters, inspecteur - adjoint qui accompagnera M. Rombaut au Congrès de l'Enseignement technique de Londres, et M. William de Fontaine, architecte de talent et professeur à l'école industrielle de Bruxelles.

Parmi les nombreuses institutions qui sortiront du World's Fair qui restera ouvert jusqu'au mois de novembre, 1897, à Bruxelles, M. le Ministre Nyssens, répondant à M. de Mot, président du comité exécutif, a déclaré que le Musée Colonial n'était pas le seul monument qui marquerait le souvenir de l'exposition, mais que la commission du "Palais du Peuple" allait voir ses travaux couronnés de succès par l'installation d'un musée scientifique essentiellement populaire dont l'ouvrier pourra retirer, outre un enseignement général, une utilité pratique.

Le Musée d'Economie Sociale sera un instrument puissant d'étude pour nos ouvriers, contremaîtres et tous les coopérateurs de notre activité économique.

B.—Enseignement Commercial.

Il m'est pénible de devoir constater que jusqu'à ce jour l'enseignement commercial primaire et moyen et les écoles de commerce ont fait peu de progrès en Belgique.

Le programme type des écoles primaires communales du 1er mai 1897, en fait à peine mention, au moins pour les branches dont la loi déclare l'enseignement obligatoire. Cela est d'autant plusregrettable que c'est parmi les ouvriers que se fait le recrutement des membres des conseils d'administration des sociétés coopératives, des caisses d'épargne, des sociétés de secours mutuels, des caisses de secours, de prévoyance et de retraite et une partie des membres des conseils d'industrie et du travail, des conseils de prud'hommes, enfin de toutes les associations auxquelles s'associent les travailleurs.

On donne dans nos écoles des notions d'hygiène, d'histoire, d'agriculture ; les notions élémentaires des sciences naturelles sont reléguées dans les branches facultatives ; il n'est pas même fait mention de l'économie politique et sociale ! et cependant le commerce unit les différentes classes de la société ; il est le lien de toutes les activités, de toutes les industries, de tous les peuples.

Une nation de producteurs doit encourager par tous les moyens possibles l'étude des sciences commerciales et économiques à tous les degrés : inférieur, moyen et supérieur.

C'est à son admirable organisation de l'enseignement technique et commercial autant qu'à sa fidélité aux principes de liberté com-

merciale que l'Empire Britannique doit sa prépondérance et cette prospérité inouie qui est constatée dans toutes les branches du travail à l'occasion du jubilé de Sa Très Gracieuse Majesté La Reine Victoria.

C.—Congrès International de l'Enseignement Commercial d'Anvers, 1898.

L'année prochaine le cercle des Anciens Etudiants de l'Institut Supérieur de Commerce d'Anvers fêtera le XXV^{e} anniversaire de sa fondation par l'organisation d'un Congrès International de l'Enseignement Commercial qui se tiendra à Anvers pendant les vacances de Pâques.

Le Congrès International de l'Enseignement Technique qui s'ouvrira à Londres le 15 juin prochain et pour lequel j'ai écrit le présent rapport sera heureux d'apprendre cette bonne nouvelle, car il permettra à tous ceux qui prennent à cœur la cause civilisatrice de l'enseignement de se réunir de nouveau, à bref délai, dans la Métropole Commerciale de la Belgique.

M. PAUL WAUTERS (one of the delegates of the Belgian Government) also gave a report upon "Technical Education in Belgium."

[Mons. Wauters's paper will be printed in a later number of the *Journal*.]

THE INFLUENCE OF VARIOUS EXAMINING BODIES ON THE PROGRESS OF TECHNICAL AND COMMERCIAL EDUCATION IN ENGLAND.

By PROF. J. WERTHEIMER, B.Sc., B.A., F.I.C., F.C.S.,

Principal of the Merchant Venturers' Technical College, Bristol, and Hon. Sec. of the Association of Technical Institutions.

Schemes of examination influence the education of a nation mainly in three ways; in the first place, they serve to mark out lines of study by the syllabuses they set forth; in the second, they fix standards of attainment by the amount of knowledge they require for various grades of success; and, lastly, they offer incentives to students and teachers in the shape of the distinctions and prizes which reward conspicuous success. The influence of any particular scheme of examination on the progress of education is good or bad, just in so far as its syllabuses are wisely chosen, its standards of success fixed neither too high nor too low, and its distinctions and prizes so awarded as to offer a premium for intelligent work, rather than for mere "cramming" of facts and theories.

It is proposed in this paper to consider to what extent the principal examinations, for which students of commercial and technical subjects enter, have exercised a beneficial influence on the progress of education in England, and to suggest certain directions in which alterations may be desirable.

The examinations which will be reviewed are those of

(1) The Department of Science and Art;
(2) The City and Guilds of London Institute for the Advancement of Technical Education;
(3) The Society for the Encouragement of Arts, Manufactures, and Commerce;
(4) The Universities of Oxford, Cambridge and London; and
(5) The London Chamber of Commerce.

It will be seen that the list makes no pretence to be exhaustive, though it is believed to be thoroughly representative.

I.—THE EXAMINATIONS OF THE DEPARTMENT OF SCIENCE AND ART.

No examinations have exerted a more widespread influence on the progress of technical education than those of the Department of Science and Art, and those who are best acquainted with the facts will be prepared to admit that, though the examinations in question may have done not a little harm, their influence has, on the whole, been beneficial, and that steady improvement has been made in the Department's syllabuses and modes of action.

In the earlier periods of the Department's existence it was driven to adopt bad methods, first, by the lack of competent teachers; secondly, by the almost entire absence of facilities for practical work in connection with the subjects of scientific instruction which it endeavoured to foster; and lastly, by the fact that the clerical division of the Department's staff far exceeded both in numbers, and apparently, in influence, that portion of its officers which had some knowledge of science, art and technology and understood the difficulties of the teachers, and the requirements of the students. All this has been, and still is steadily changing; the number of competent teachers is rapidly increasing; well-equipped laboratories of all kinds are springing up all over the country; and the expert side of the Department's staff has been greatly strengthened. The appointment as Director for Science of a former inspector and distinguished scientist—Captain Abney—has already led to great improvements, and creates a hope that still better things may be in store.

Within the last few years the Department has taken steps to recognise practical work, not only in chemistry and metallurgy, but also in physics and biology. It is to be hoped that in a short time it will not merely recognise but will require this, and that it will take steps to encourage practical work in connection with other subjects such as mechanics and the theory of the steam-engine.

The recent establishment of separate day and evening examinations, encourages the belief that the Department may, in time, see its way to draw up separate syllabuses suitable respectively for the pupils in the day schools connected with it and for the adult artisan pupils of its evening classes.

II.—THE EXAMINATIONS OF THE CITY AND GUILDS OF LONDON INSTITUTE FOR THE ADVANCEMENT OF TECHNICAL EDUCATION.

While the Department of Science and Art owes its origin and the funds it distributes to the action of Parliament, the City and Guilds of London Institute is maintained by the ancient trades' corporations of the metropolis.

The examinations of the institute have undoubtedly exercised a beneficial influence on the teaching of technology; but there is still room for improvement in the syllabuses of the examinations, and it is very desirable that the institute should insist more largely on evidence of practical skill.

The professional element on the Examination Board is at present entirely drawn from the staffs of the two colleges which the Institute controls, and while every one must be pleased to see these eminent teachers on the Board, it is greatly to be desired that the Institute should associate with the professors in its own colleges representatives of the professors and teachers in the leading provincial technical schools and colleges.

At present the examinations of the Institute in many subjects are quite beyond the reach of the majority of young artisans. This is unfortunate, and a great impetus to apprentices to study would be given by the subdivision of the work required for the ordinary grades into two or even more parts, which might be taken in different years. It would also tend to popularise the examinations and the classes preparing for them, if, in place of the present certificates, a "journeyman's" and a "foreman's" certificate respectively were issued to artisans who produced evidence of the necessary training in the workshops of an approved firm, and who subsequently passed the Institute's theoretical and practical examinations. The honours grade certificate might then be made still more difficult of attainment than at present, and would be suitable for those desirous of becoming captains of industry. It is only necessary to point to the fact that in mechanical engineering only 481, in boot and shoe manufacture only 208, and in calico printing only 31 candidates sat for examination in 1896, in order to convince all concerned that the Institute still covers only a small part of the field which is open to it.

III.—THE EXAMINATIONS OF THE SOCIETY FOR THE ENCOURAGEMENT OF ARTS, MANUFACTURES AND COMMERCE.

The Society of Arts (to give it the title by which it is best known) does for commerce what the City and Guilds of London Institute does for technology. Meeting, as this Congress does, in the rooms of the Society, it is but proper that it should note specially the deep obligations of the business world for the care with which the Society has fostered training in commercial subjects. Its examinations are steadily increasing in favour, and its certificates are with justice highly valued. Probably for financial reasons there is, however, in the examinations in modern languages no provision made for testing and giving credit for a candidate's ability to speak these; it is to be hoped that a way may be found to remedy this defect, and thus indirectly to help British merchants who may wish to find commercial travellers able to meet, on approximately equal terms, those whom our German cousins send out so well prepared and in such abundance. It would also be an improvement, if the Society were to issue both "Junior Clerks'" and "Senior Clerks'" certificates to students who gave evidence of satisfactory service for, say, three and six years respectively in houses of business approved by the Local Chamber of Commerce, and who subsequently passed certain of the Society's examinations; certificates of this kind would soon come to possess a very high value in the commercial world.

IV.—THE EXAMINATIONS OF THE UNIVERSITIES OF OXFORD, CAMBRIDGE AND LONDON.

These universities influence technical and commercial education in two ways. They grant degrees to those about to become teachers, and by the local examinations of the ancient Universities, together with the Matriculation Examination of the University of London, provide tests of the completion of the substratum of general education which students should possess before they enter upon a course of higher technical or commercial training. As regards Oxford and Cambridge, enormous strides have been made of late years, in the provision of laboratories and apparatus, and their distinguished students of electricity, for example, are no longer indebted to text-books alone for their knowledge of dynamos.

Oxford and Cambridge, unfortunately, do little to encourage undergraduates to obtain a conversational knowledge of modern languages. Of course a University student should require a thorough literary knowledge of a modern language, but it is difficult to understand why, *e.g.*, in the Modern Languages Tripos at Cambridge, no marks are assigned for ability to speak the languages chosen, though candidates who can do this have their names distinguished by an asterisk.

The University of London has greatly helped technical education by requiring for its degrees in science an adequate amount of practical work, in addition to severe theoretical examinations. As a a result, many of the most important teaching posts in technical schools and colleges are filled by graduates of this University.

The Local Examinations of the Universities of Oxford and Cambridge have lately been greatly improved by the introduction of a new, though unfortunately optional, syllabus for elementary science, which involves something more than the mere book-knowledge still sufficient for success under the alternative schemes. It is to be hoped that practical work in science may soon be included in the matriculation examinations of the University of London.

V.—THE EXAMINATIONS OF THE LONDON CHAMBER OF COMMERCE.

The London Chamber of Commerce has put forth certain schemes for commercial education and has held examinations thereon, but so far these examinations have not been very generally accepted. A very important point in the syllabus of the Chamber is that in modern languages conversational knowledge is required. The multiplication of examining bodies is, however, in every way undesirable, and it is difficult to see why arrangements could not be made by this Chamber—or better still by the Association of Chambers of Commerce of the United Kingdom—and the Society of Arts, for an amalgamation of their forces in order to secure one set of examinations for commercial certificates for the whole country.

GENERAL OBSERVATIONS.

It behoves us to watch closely any attempt to establish new examinations. The Technical Instruction Committees of some County Councils are already instituting examinations of their own; in a very few cases these may be necessary to meet special local requirements. But as a rule they are not needed, and it would be wiser to endeavour to modify existing examinations, if necessary, rather than to establish new ones.

In fact there are not a few of us who would be prepared to make the establishment of a new examination a misdemeanour at the least, unless the examination took the place of one or more already in existence.

As another instance of unnecessary examinations, that conducted by the Worshipful Company of Plumbers may be mentioned. The examinations of the City and Guilds of London Institute in plumbers' work are at the least as well arranged, and it is to be hoped that the Company may soon see its way to accept the Institute's examinations and withdraw its own.

In the important subject of cookery we suffer at present from the too great energy of the rival examining bodies. It would be matter for congratulation if they would consent to hand over their examining functions to some external body such as the City and Guilds of London Institute; the certificates issued would then have the same value all over the country, and their validity would not be confined to certain comparatively limited areas as at present.

In conclusion, it is, however, gratifying to note that in the departments of technology and commerce we do not find that multiplication of examinations which is so great a misfortune in the region of general secondary education.

A GERMAN TECHNICAL COLLEGE FROM AN ENGLISH POINT OF VIEW.

By EDWIN O. SACHS.

When I handed in the title of this paper, I was under the impression that the time available for reading it would have been the conventional one hour generally given to a lecture, and I had intended making an attempt to describe the chief features of a well-known German Technical College in all its departments. As it has been found necessary, however, to reduce the time available for each paper to twenty minutes, I am afraid that I shall have to confine my remarks to one of the sections of the institution with which I am to deal.

This institution is the Royal Technical College at Berlin, which, to my mind, is the leading establishment of its kind to be found in the German Empire, or, for the matter of that, in German-speaking countries, Austria included, and the section to which I shall more especially devote my remarks will be the Architectural School or division of that institution. As an architect who has studied and enjoyed the facilities of this special division it will be easily understood that I should give preference to the department of which I have had considerable personal experience.

In the first place, I shall give a brief outline of the origin of this institution. The Berlin Technical College, as it now stands, has been in existence for only thirteen years, for it is since 1884 that it has occupied the premises it now holds. The scheme of organisation on which the establishment was based, however, dates from 1879, the intervening period being utilised chiefly for the preparation of the necessary buildings, which were designed and executed on a lavish scale. The present nature of the institution has grown out of an amalgamation of the old Architectural Academy at Berlin and the Engineering Academy of the same city, which previously had separate existences. They had passed through similar phases of development, both having been started in a very modest way during the early years of the present century. These establishments were organised under the Prussian Government, and both were owned and practically managed as the property of the Prussian people. The new institution is also essentially a Prussian one, on which the Government spends annually a considerable sum of money, and this point as to the ownership of the original, and subsequently of the new, establishments is an important feature to be remembered.

The old Architectural Academy, to which I have just referred, though only in working order in the opening days of the present century, officially dates from April 8th, 1799, when a Charter for a new "Bauschule'—literally "Building School," or better, "School of Building Construction"—was signed by the reigning king, Frederick William III. Its organisation was primarily for the education of architects and surveyors who proposed entering Government service. The first curriculum of this early period includes no less than twenty-three subjects, and, though the qualifications for entry to the classes consisted almost solely in the possession of a good character and elementary education, the scope of the instruction was by no means limited. I should, perhaps, add that this institution was one of the first of its kind on the Continent. The old "Building School" very soon became popular, and consequently its development was rapid; so much so indeed, that greater restrictions had to be placed on those wishing to become students. A few years later, we hear that one year's practical experience in an architect's or surveyor's office was a primary condition for attendance at these classes. In 1801 no less than fifty pupils attended the schools, and in 1805 the number had risen to seventy. Here I would particularly emphasise the fact that the establishment embodied only the requirements indicated by its title; it was a building school, pure and simple—not an architectual school in the modern sense. The classes were essentially of a practical nature. Architecture, as an art, and design, from an artist's point of view, were subjects dealt with by the Prussian Royal Academy of Art, which had then, as it has now, its architectural studio, and to which members of the "Bauschule" might belong. It was not until the year 1828, when Professor Stier was one of the leading masters of the old establishment that the art side of an architectural education received the attention that it had long merited from the executive, and soon after, in 1835, more suitable accommodation for the development of this side was found in an extensive block specially erected by Schinkel. In 1849 the "Building School" underwent reorganisation, and became a *bonâ fide* architectural academy, managed on the university lines, and with all the freedom traditionally associated with German university life, and this not only refers to the organisation of the establishment as such, but also, on one hand, to the spirit with which masters treat their students, and, on the other, to the manner in which the students applied themselves to their studies. The organisation of 1849 practically remained unchanged until the great amalgamation of 1879 already alluded to. Throughout this period the courses were followed by an examination which entitled the successful candidate to certain claims for Government employment, and gave him the title of a Government architect, even if he did not chose to avail himself of a public office, but preferred to practise privately as an architect or surveyor.

It would lead me too far, were I to touch in a similar manner on the interesting development of the Engineering Academy, and hence I shall only note that in 1812 it was first known under the title of the Berlin Technical School. Its development was, as I have said, not unlike that of the Architectural Academy, both as regards classes, conditions of entry, and so on, while in 1850 it was similarly re-organised on university lines, and from that date became an engineering academy proper. Mechanical and mining engineering, naval architecture, and chemistry, were comprised in its programme, and each of these sections was, to a certain extent, regarded as a separate department of the establishment.

The amalgamation of these two academies took place, as stated, in 1879, and resulted in the establishment of the Royal Technical College, which in every way possesses a university status, and is in no way to be compared to what we term a "Technical College" in this country. In order that the college may offer the best opportunities for the most efficient education, the executive retains the leading men of the time for its professional chairs. The social and educational status of the student is high, for every candidate is expected to have enjoyed a superior education at a first class school. From a German point of view, the expense of sending a youth to this college is by no means a small matter, though it may seem slight in comparison with English university fees. The whole time of the student has to be given up to his college work, a full course of instruction occupying four years, or perhaps longer. The Royal Technical College has its five distinct branches, or, if I may employ the academic term, faculties, (1) architecture, (2) civil engineering, (3) mechanical engineering, (4) mining engineering, chemistry and mineralogy, (5) general technical science. Each division has its distinct head, who is generally a *savant* of considerable experience elected from among the body of professors of the section in question, and the chancellor, vice-chancellor, and general council of the establishment are elected on similar lines, subject to the approval of the Government and the sanction of the Sovereign. The professorships are in the gift of the king, the tutorships are granted by the executive. The students rank with university students, and their characteristics and pastimes are almost identical. The Royal Technical College is housed in what is doubtless the finest building ever devoted to an educational establishment of this description; in fact, it is quite a palace, having considerable architectural pretensions. It cannot be too much impressed on those who have witnessed our technical classes carried on in almost squalid surroundings, how important it is that we should give to technical students a home which in every way embodies the achievements of this age of progress in technical science and does credit to the period of architecture to which it belongs. I should much like to describe the beautiful building and its practical equipment, which might well serve as a model to the world, though its conception is perhaps almost too elaborate and too costly from an economic point of view. I must, however, content myself with saying that its dimensions are approximately 700 feet by 300, that it has five courts of which the central one is covered in, and that it has four storeys, all of considerable height. Its lecture rooms are spacious and numerous, and its class rooms and studios thoroughly serviceable and well lighted. The number of students for which it was intended was two thousand, and to-day, although there are 2,913 on the books, it still admirably fulfils its purpose; but the popularity which its educational facilities have won for it will no doubt soon compel a considerable extension being made. Of these 2,913 students, I should here perhaps at once add that there are only 366 architectural students fully matriculated, with 221 non-matriculated, making in all 587, whilst the mechanical engineers number together nearly 1,300. I should also, perhaps, add that there are a considerable number of foreigners among the students, Russia, for instance, regularly sending a large contingent.

But, turning now to the courses available for students of the architectural section, I ought first to say that besides the subjects taught in the architectural division proper, much that is valuable is to be learned from the civil engineers' department, in the general technical classes, &c., and special facilities are afforded to the architectural student for attending suitable lectures in other sections. The architectural division has eight ordinary and twelve extraordinary professors, and fifteen tutors, headed, as I have said before, by a divisional chief elected from among the professors. The courses available include a large number of different lectures on various periods of architectural and art history; with elementary and advanced drawing, free-hand, perspective, geometrical and architectural draughtsmanship, water-colour work and modelling. Then again there are classes for the general planning of private dwellings and public buildings of all descriptions, for design in various specific styles and for divers purposes, the designing of ornament, of furniture, of lead-glazing, metal work, &c. In addition to these, there are exhaustive lectures on the evolution of particular features in design, such as that of ornament; while among the more practical subjects every form of construction is taught, from the simplest brickwork to the most complicated iron-roofing. The characteristics of different materials are also important subjects dealt with, as are heating and ventilation. Special forms of building are also treated as separate subjects, as well as the varions equipments. For instance, we find lectures on the necessary appliances for hospitals, prisons, and libraries. Building legislation is moreover not overlooked. Turning to the lectures which are given in other sections we find those on mathematics, physics, statics, geology, chemistry, book-keeping, and general elementary law, included in the curriculum of the general science division, and in another department the housing of the working-classes—in fact, there are few German requirements which are not fully attended to at this college. I use the expression "German requirements" advisedly, for sanitation, which really occupies a very secondary position in a German architectural practice, receives scant treatment at this institution. And again, the measuring up and sketching on the spot, which we consider so important, the German architect does not appear to appreciate, and as a subject of study it is almost overlooked in the Berlin curriculum. Of course the student has to select his own subjects and to distribute them over the four years which he spends at the technical college, and if we turn at random to the list of subjects taken up by a first year man on, say, a Tuesday, we may probably find that in the forenoon he attends lectures of an hour each in mathematics, elementary construction, and a class in elementary drawing; and in the afternoon, perhaps, a lecture of one hour on geology or materials, followed by a class of elementary draughtsmanship of from two to three hours' duration, including, say, instruction on the classic orders. If we were then to take a fourth year student's list for the same day, we might, on the other hand, find a two hours' lecture on the history of architecture, and a two hours' class on design in the Rennaissance style; then, in the afternoon, he may give a couple of hours to practical design, such as the planning of public buildings, and attend an hour's lecture on heating and ventilation. From these examples it will be seen that in the earlier stages of the Berlin student's work, he seeks to obtain a foundation in draughtmanship and science, while at the latter end of his course he devotes most of his time to the designing of buildings, some to historical study and to gaining a knowledge of special equipment. It would no doubt be interesting to follow the architectural student's career from year to year or from term to term, but this would take too long, and I therefore only quote a couple of examples from a student's time-table.

But now, after these historical and descriptive notes on the Royal Technical College at Berlin, I would ask if there are any disadvantages in the system of architectural education adopted by the Prussian Government. To my mind, though the opportunities for study are delightful, there is obviously something wanting in the whole system. Every preparation is made for the student to obtain knowledge, yet the result is by no means as satisfactory as might be expected. Does not this arise primarily from the student starting fresh from school without any previous elementary practical knowledge of construction? He has never been on a building in the course of erection, and does not know the difference between a piece of oak and a piece of deal. Further, owing to his not having seen an actual moulding cut, he has no idea of the method of its production. For four long years he spends nearly the whole of his time in theoretical study, and, as far as my experience goes, there are but few men who utilise even the smallest part of their leisure in getting some idea of the nature of practical work. Does not a school where merely the theory of architecture is taught have a tendency to produce an architect of an academic character, though of course there may be the usual exceptions of brilliant and talented men, or those who are ambitious and energetic and who do not follow the lines laid down for them? Do not many of the masters, too, in such a school, soon lose all touch with practical work; and, though brilliant scientists or historians on receiving their professorships, do they not lose all sympathy with the movements of the times, and even by going through the same course regularly, year after year, become mechanical and uninteresting in their methods, inspiring no enthusiasm in their pupils? I think there can be little doubt that, as in Berlin, for instance, so always the best and most popular masters are those few who keep in constant touch with current thought and practice.

As to the remedy for any unsatisfactory results, would it not be advisable that a boy should have a year's practical work in an office, with the run of some works for at least six months before he starts his elementary studies at the college, and should not every six months of theoretical study be interspersed with three months of practical work? Should not lessons in design be accompanied by lessons in the measurement of existing buildings, to enable the student to grasp the appearance of what he is putting on paper? Would it not be well, too, that the instructors in design, construction, and special equipment, should one and all be men actually in extensive practice, and that such subjects as history, the elementary sciences, and freehand drawing, should be left to men whose vocation is chiefly to impart knowledge, yet who should be compelled to keep themselves abreast of modern progress?

We have had under consideration an establishment organised on the most elaborate lines, in which there is but little left to improve, as far as the syllabus of the classes is concerned. The Berlin Technical College has been on its trial for over twelve years, and the results, to my mind, are not at all proportionate to the amount of time and money expended by the architectural student and the Prussian Government. Indeed, as the Berlin Technical College is in many respects a model to those advocating architectural education, so it must also serve as a warning to those extremists who would advocate merely theoretic study as the primary basis of a training in architecture and its actual practice. Much as we can learn from leading men in special technical subjects, the Berlin College only too plainly shows what harm can be done by taking an able man entirely away from his profession, and thus preventing him from keeping in touch with that practical work which brought him into prominence.

I would conclude by saying that the architectural school at the Royal Technical College of Berlin is an institution well worthy of our attention, and in many respects of our imitation; but, at the same time, we must observe the disadvantages of too theoretical an education, and its evil effect upon a student destined for actual practice. What I have said with regard to the architectural school, I believe, holds good in many respects for the several engineering divisions of the same college.

THE SOCIETY OF ARTS' EXAMINATIONS.

By Sir Henry Trueman Wood, M.A.,
Secretary of the Society.

The Society's Examinations are conducted simultaneously at a number of different centres throughout the kingdom, through the agency of local examination committees established for the purpose by the Society. The papers in each subject are sent down in separate envelopes to the secretary of the committee immediately preceding the day of examination. The envelopes are opened in the presence of the candidates, and the papers distributed. The worked papers are sealed up at once and despatched to the office of the Society. In the present year, 1897, 7,513 papers were worked by 6,919 candidates at 221 centres. The subjects in which examinations are now held are:—1. Arithmetic; 2. English; 3. Book-keeping; 4. Commercial Geography; 5. Shorthand; 6. Type-writing; 7. Economics; 8. Précis-writing; 9. French; 10. Elementary French; 11. German; 12. Elementary German; 13. Italian; 14. Spanish; 15. Elementary Spanish; 16. Portuguese; 17. Russian; 18. Danish; 19. Chinese; 20. Japanese; 21. Domestic Economy; 22. Rudiments of Music; 23. Harmony; 24. Practice of Music.

The examination system of the Society of Arts was an outcome of the Great Exhibition of 1851, which, as is well known, was originated by the Society.

In November, 1851, Mr. Harry Chester, then a Vice-President of the Society and afterwards Chairman of the Council, submitted to the Council a scheme for the formation of a union of mechanics' institutions, the principal object of which was to encourage the founding of such institutions, and to develop the educational facilities which they provided.

Among the early suggestions for the utilisation and development of such institutions was a proposal for a general system of examinations among their members. In December, 1853, Mr. Chester definitely proposed the establishment of such a system, and in the spring of 1854 a scheme of examinations was published. The scheme was of a very comprehensive character, and included the following subjects:—1. Mathematical Sciences; 2. Experimental Sciences; 3. Sciences of Observation; 4. Mechanical Sciences; 5. Social Sciences; 6. Fine Arts; 7. Moral and Metaphysical Sciences; 8. Literature. This very elaborate programme proved a little impracticable, and it is not to be wondered at that only a single candidate offered himself for examination in March, 1854. The promoters of the movement were not, however discouraged, the scheme was remodelled, principally by Dr. Booth, at that time an active member of the Society, and in 1856 an examination of 52 candidates was held at the Society's house. The subjects of this first examination were:—1. Book-keeping; 2. Arithmetic; 3. Algebra; 4. Mensuration; 5. Geometry; 6. Mechanics; 7. Chemistry; 8. Animal Physiology; 9. Botany; 10. Agriculture; 11. Geography; 12. Physical Geography; 13. English History; 14. English Literature; 15. Latin and Roman History; 16. French; 17. German; 18. Freehand Drawing.

In the following year, 1857, the first attempt at provincial examinations was made, and an examination was held at Huddersfield, as well as in London, the examiners of the Society going down for the purpose. The desire of increasing the number of examination centres, and the obvious impossibility of sending examiners simultaneously all over the country, led in 1858 to the elaboration of the system of local committees to supervise examinations worked from a single centre.

The Society of Arts, however, cannot claim the sole credit of the invention of the system of local examinations. In 1850 the College of Perceptors (established in 1846) was considering the best means of examining the schools of its members. It commenced by sending down examiners, but in 1853 the experiment was tried of collecting pupils to a centre and examining them by means of papers sent down from London. The experiment proving successful, the system was regularly organised in the following year, 1854, and has been continued ever since.

It will be seen that the College of Preceptors' Examinations preceded those of the Society of Arts by two years, but the objects, the conditions, and the methods of the two systems have been so different that there has never been any but the most friendly rivalry between them. In 1856 a conference was held at the Society's house between representatives of the two bodies, the College being rather afraid that the Society's Examinations would interfere with their own. It was soon apparent that the two systems were intended to occupy different ground, and were not likely to affect one another. In practice this has proved to be the result, and it has never been found that the two systems have interfered in the least with one another.*

To the Society's Examinations in 1858, 58 institutions sent up 288 candidates; in the following year there were 480; in 1860, 586. The numbers increased steadily till 1865, when there were 1,899; the next year showed a slight diminution, and then there was a further increase, till the number of 2,160 was reached in 1869.

The University Local Examinations were established in 1858. The establishment of Elementary Drawing Examinations by the Department of Science and Art was about contemporaneous with that of the Society's Examinations. The Science Examinations began later, in 1861, and as these developed, it was found that the Society's Examinations were in many respects competing with those of the Department. The same candidates were being examined in the same subjects, and there was an evident waste of power. In 1870 this led to the abandonment of 17 out of the 36 subjects then included.

In 1871, when the Council were considering the establishment of a system of Technological Examinations, of which an account is given below, they passed a resolution to discontinue the General Examinations, but on the application of some of the more important of the Institutions in Union, they rescinded the examinations resolution and determined to continue for a further period. This was done, on the same system as before, till 1876, when the programme was revised, and the plan on which certificates were granted was somewhat modified. Previously, certificates had been granted for single subjects, but in that year a "Commercial Certificate" was established in addition, to take which it was necessary to pass in, at least, three subjects. Very few of these certificates were ever taken, the system of single certificates for single subjects being more popular and better suited to the needs of the class of students who take up the Society's Examinations.

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* The writer of this memorandum may be permitted to mention that he was for a short time one of the examiners of the College.

In 1879, the question of abandoning the examinations again arose, it being thought that the ground was covered by other agencies. To quote from the report of the Examination Committee in 1879:—

> "The Committee feel that the time has now come when the Society should cease to compete with other educational agencies more influential in the work of examination. With the Educational Department examining millions of children in elementary schools, and thousands of young persons in night classes; with the Universities holding their local examinations throughout the country, for young persons of a higher class; with the Science and Art Department examing students in every branch of science and art; with the new City Institute devoloping yet further the Technological Examinations just handed over to them by the Society; with other agencies, such as the College of Preceptors, doing kindred work, the Society of Arts may well retire from the field, having in all these various directions acted as the pioneer. It held science examinations before the Science Department, examinations in literature before the Universities went afield to meet the classes who could not go to Oxford or to Cambridge. It has seen the system it established develop, with the aid of Government funds, as it could never have grown without such help, and the time has now arrived when it may cease to compete with the agencies it has done so much to foster."

In pursuance of the course mentioned in this report, no examination was held in 1881, but again, however, some of the institutions where the examinations were held protested, and on further consideration it was determined to continue the examinations, but to try whether they could not be made self-supporting. Hitherto they had been free. In 1882 a fee of 2s. 6d. was charged to each candidate, and this charge has been continued to the present date. The "Commercial Certificate" was abandoned and the old system was resumed of giving a separate certificate for each subject. The natural result was a considerable falling off in the numbers examined. In 1882 only 695 papers were worked as compared with 2,325 in 1880. The numbers, however, soon began to increase again. In 1890 there were 2,474; in 1894, 4,375; in 1895, 5,108, and in the present year, 7,513. This very considerable increase is doubtless, to a very great extent, due to the fact that the County Councils have now large funds available for the promotion of technical education; and that certain commercial subjects are scheduled by the Science and Art Department as subjects coming within the scope of the Technical Instruction Act, 1889. The commercial subjects so scheduled are precisely those in which the Society of Arts has now for just forty years been holding examinations.

The Technological Examinations, referred to above, were instituted in 1873, at the suggestion of Sir John Donnelly. These examinations were intended to test the knowledge possessed by artisans of the subject matter of their respective industries. It was arranged that they should be held in connection with the May examinations of the Science and Art Department, the technological papers being given out with those of the Department. Before a candidate could obtain a certificate, he was required to pass a Department examination in certain specified science subjects, these varying according to the technological subject taken up. Certificates of three grades were given, elementary, advanced, and honours, corresponding with those of the Department examiners. No attempt was made to test practical skill, but each candidate was required to produce a certificate from his employer in which his competence was stated. The number of candidates was never great. In the first year (1873) only six entered and the numbers gradually increased to 68 in 1870 and 184 in 1878.*

In 1879, on the foundation of the City Guilds' Technical Institute, the Technological Examinations were handed over to that body. From the funds placed at its disposal by the City companies the Institute was able to offer to teachers payments on the results of the examination in the same manner as the Science and Art Department does for its examinations. Teachers were thus enabled to form classes and send pupils for the examination, and a large increase in the number of candidates took place. These examinations now form an important part of the Institute's work, and attract annually a very large number of candidates. In 1897 the number entering was 29,494. Large additions have also been made to the list of subjects, which now number 63. No great change has been made in the general character or system, which remains much the same as that proposed by Sir John Donnelly, but the details have been considerably modified, and in some cases a practical examination, to test handicraft skill, has been provided.

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* The following were the subjects included in the 1878 examinations:—Cotton manufacture, Paper, Silk, Steel, Carriage-building, Manufacture of Pottery and Porcelain, Gas manufacture, Glass, Cloth, Silk-dyeing, Wool-dyeing; Calico-bleaching, dyeing, and printing; Alkali manufacture, Blow-pipe analysis.

In addition to the examinations above referred to, the Society conducted, from 1856 to 1894, Elementary Examinations. These were really carried on by District Unions and Local Boards in connection with the Society. All the Society did was to supply identical examination papers, the results being examined and certificates awarded by examiners appointed by the Local Boards. The Society supplied the certificates, but accepted no responsibility as to their award. The system, though useful at its first establishment, was never found to work in a very satisfactory manner, and in 1895, the place of these examinations being better filled by examinations entirely under the control of local institutions, the Society's system was abandoned.

THE TEACHING OF DRAWING IN CONNECTION WITH TECHNICAL AND COMMERCIAL EDUCATION.

By T. R. Ablett,
Honorary Director, Royal Drawing Society of Great Britain and Ireland.

Whether Englishmen have less art appreciation than some of their continental neighbours, is a matter of controversy, but there is no doubt that in English schools drawing receives less time and attention, and is taught to fewer pupils than in many other countries.

In France, it is taught to every boy and girl in primary schools for four hours each week, and in secondary schools for eight hours.

In Germany, Austria, Belgium, Sweden, Switzerland, and some of the Australian colonies it is compulsory for all children. It is said that it will soon be as disgraceful in America not to be able to draw, as not to be able to read and write.

Contrast this with the state of drawing in England. In the elementary schools not more than two hours is given to the boys who are taught, and the girls need not learn at all. In the secondary schools, many boys and girls are not taught, and one hour a week, or a little over, is considered ample for those who do learn.

No one can deny the advantages of *mechanical drawing*. The individual who can draw with ease and accuracy, can gain skill in any kind of manual industry much more quickly than would be possible without such power. The drawing of an object is an excellent preliminary to the making of the same. The acquirement of accuracy in measurement produces habits of precision which directly lead up to skilful handicraft. The difference between the skilful and unskilful workman is mainly that the former fashions his products the exact size required, and the latter makes them wholly or in part too big or too little for their purpose, and so wastes time and material for which the consumer pays. It has been said that nine-tenths of English workmen cannot understand a plan, elevation, or section. Waiting for the foreman's explanation increases the cost of production by wasting the workman's time. Drawings are superior to spoken or written language, in supplying adequate means for making inventive thought manifest. Working mechanics often waste time and money in making models that will not act. A knowledge of drawing would enable them to put their ideas on paper, and save the waste involved in making a useless model. Similarly geometric drawing is most useful in connection with the study of physics and engineering. By its aid the higher mathematics can be understood before it is possible to learn the processes of exact mathematical proof.

There are many advantages to be derived from *artistic drawing*, not only to art manufacture, but to general education. The Royal Commission appointed to inquire into the Elementary Acts reported, "That drawing is a subject of the utmost importance, and that at no time in a child's life can it be so easily taught as during the period of schooling."

Why does England miss its golden opportunity in the boys' and girls' schools? Is it not because those who have charge of the general education of the children in this free country, have never been convinced that drawing is a means of training a child's faculties. *There is great danger that they may become still less sympathetic if those who are interested in technical education speak only of the training of the hand and eye, and ignore that which is also essential to drawing—the training of the mind.*

The Royal Drawing Society has made a serious effort to win the co-operation of the general teacher, and its success demonstrates the possibilities in this direction. It has gathered to it hundreds of schools, and many thousands of their pupils have been candidates in its annual examination, or exhibitors in its annual exhibition.

This Society makes clear that the cultivation of the observation is an essential in acquiring skill in artistic drawing, as it is in developing the general intelligence, and the great economy of constantly employing drawing to record the results of observation whatever be the subject of study. Especially is this desirable in the case of young children. Differences of shape greatly excite their minds. New shapes, beside the charm of novelty, indicate structure and use, and a child is naturally impelled to employ the readiest language (drawing) in setting down its recollection of them. The thoughtful general teacher can find out the accuracy of a child's touch with its environment by carefully considering these spontaneous records, and by judicious encouragement develop the mind and drawing power *pari passu*. There is no doubt that under favourable circumstances, this spontaneous drawing of childhood developes and merges into the draughtsmanship of the adult artist, as is well illustrated by the history of Giotto, Sir John Millais, Sir Edwin Landseer, Sir John Tenniel, Mr. Briton Riviere, and many others.

The schoolmaster's task is not increased, but made easier, by incorporating drawing with the other school subjects, and this is true not only of artistic drawing but also of mehanical drawing. Drawing to scale, and the drawing of plans and elevations, if taught as an essential part of map and contour drawing, assist the acquirement of geography, and make the diagrams of science and other school subjects easy to read and remember. A noisy appeal to the ear has hitherto been chiefly relied upon, and the possibilities of acquiring knowledge quietly through the eye has not been sufficiently considered. Memory drawing aids the spelling of English words which demands a power of remembering the look of words, since their sound is not always a trustworthy guide, and it renders easier the difficult forms of the script letters, which must all be stored in the memory. It also aids the imagination by making more definite the mental picturing of many facts of history and of physical and political geography, and it makes the recollection of various appliances and scientific apparatus more thorough. All this drawing, which is the natural outcome of a schoolmaster's efforts, would be a boon to the technical school, in that its new pupils would possess on entering a practical knowledge of a subject which underlies nearly all its work.

The Royal Commission on Technical Instruction, no doubt for similar reasons recommended for elementary schools, "That the Inspectors of the Education Department, Whitehall, be responsible for the instruction in drawing."

The opinion of various authorities supports the view which the Royal Drawing Society takes, of the importance of drawing as a means of general education.

The late Lord Leighton wrote to me, December 13, 1894—"I am strongly in favour of widespread and general teaching at school of drawing, as a practice likely to develop the perceptions, strengthen memory, and usefully train the hand."

Mr. Briton Riviere, R.A., in a speech reported in the *Times*, February 1, 1896, said:—"He thought that the use of drawing, not as an end, but as a means to an end, that end being the cultivation of the mind, had been far too much neglected among us."

Dr. Bryant, a member of the Royal Commission on Secondary Education, in a speech reported in the *Daily News*, February 8, 1896, said:—"Every child should learn to draw, for drawing was an expression of the human mind, and those who were deprived of it were handicapped on one side of their mental development. The mind developed by expressing itself, and it was therefore important to develop visual imagination, and to cultivate visual imagination through the hands."

The Royal Drawing Society, in its efforts to encourage drawing as a means of general education, has found it necessary to recognise certain principles as essential to the task of teaching every boy and girl to draw:—

1. That the methods of teaching need to be adopted to the natural evolution of drawing power in children.
2. That the instruction must necessarily be imparted by the collective method, which has been found of absolute importance in teaching large classes the other school subjects.
3. That the limited time afforded for the study of the subject prohibits the use of any but the most direct and expressive processes of delineation.

Sir Henry Trueman Wood, who presided when I read a paper in this room on May 2, 1888, on "Drawing as a Means of General Education," said:—"The uses of drawing were obvious, but it was a novel point to insist upon it as a method of training the mind." It is by so encouraging it that the Royal Drawing Society has secured so large an amount of co-operation in the schools, and it seems desirable to press upon this Conference the harm of losing the sympathy and very valuable help of the general teacher by dwelling on the uses of mechanical drawing as a means of training the hand and eye, without also insisting on the mental training, and help to general education of both mechanical and artistic drawing.

WEDNESDAY MORNING, 16TH JUNE.

SECTION B.

Major-General Sir OWEN TUDOR BURNE, G.C.I.E., K.C.S.I., in the chair.

AGRICULTURAL EDUCATION.

By F. J. LLOYD.

THE OBJECT OF EDUCATION.

The object of education may be defined as that training in youth which will enable a man to earn his own living with the minimum effort and the maximum return.

This can only be attained by utilising to the fullest the natural gifts, powers or faculties—call them what you may—with which each one is more or less endowed by nature.

Hence it is not surprising that Herbert Spencer has defined the object of education in the following words :—

> "How to live? How to use all our faculties to the greatest advantage of ourselves and others—how to live completely? This being the great thing needful for us to learn, is, by consequence, the great thing which education has to teach."

The greater portion of mankind earn a living by manual rather than by mental work. Hence a perfect system of education should not only discover but train both the manual as well as the mental capacities of each individual.

Agricultural education more than any other demands this double training. The pursuit of agriculture requires great manual skill, while every operation is influenced by more natural forces and utilises more natural laws than the operations of any other industry in the kingdom. It is almost superfluous to mention that the study of these laws is termed science.

EDUCATION IN THE PAST.

But what has been the education given in the past to those who would follow the pursuit of agriculture. In the education of the past, as in much of that given at the present time, the fact that men were possessed of such faculties has been utterly ignored, much less that these faculties varied with each individual. Hence there has been no attempt to draw out or train these faculties, the sole object of education being to cram a certain number of useless and disconnected facts or pseudo-facts into what is termed the brain. Teachers recognised one faculty, and one only, viz., memory, and to train this one faculty to the neglect of every other has been the sole object of education for ages past, and remains so mainly to the present day. It has entirely neglected to develop manual skill, it has neglected to draw out or cultivate any mental faculty save memory, and even for this purpose has utilised subjects, the recollection of which would in no wise benefit the future farmer. But far worse than this it has neglected the most valuable of nature's gifts to all of us, the strongest natural faculty we possess, observation. What is the most striking faculty possessed by a child from three to six years of age? The power of observation. Watch that same child between the ages of thirteen and sixteen and the power, though at times manifesting itself, is gradually becoming dormant, partly because it has not been cultivated, partly from its constant suppression by the ignorance and heedlessness of those who surround the child.

Ten years later the faculty is practically non-existent, lost from neglect of use, as a singer might lose the power of song, a musician the power of execution.

The difficulty now found in improving agricultural education depends greatly upon this failure of the past.

RURAL CONTEMPT FOR EDUCATION EXPLAINED.

Many leading farmers are men whose so-called education, I should prefer to call it "schooling," has been of the slightest and worst description. They now know, from experience, how little that "schooling" has contributed to their success in life, probably not one jot or tittle. Such men look askance at education and modern educational movements. If they do not openly oppose them as unnecessary, they remain passive on-lookers, saying or thinking, "I managed to do without such education; why should it be necessary for the coming generation?" Hence in rural districts throughout the whole of England the progress of education, especially of technical education, has been slow, and has met with considerable opposition. The reasons for this are really threefold. First, those who have been successful farmers know by experience how little they owe their success to the schooling of their early days. Secondly, they cannot appreciate how the knowledge whereby they have succeeded and which they obtained from practice, can be obtained in any other way than by the long and narrow path of experience which they have traversed for years. And, lastly, where they have watched the gradual growth of modern education, they find it difficult to discover results which in their opinion are commensurate with the trouble, time and expense that has been bestowed on the work.

Let me try to meet these arguments. What does success in every industry depend upon? Success depends upon a combination of skill and knowledge. Skill is the outcome of experience in manual work, whether it be the skill of an artist, a musician, a cheese-maker, or a plough boy. In every instance such skill is the outcome of experience or practice, without which it can never be attained. Knowledge on the other hand, is the result of study (reading), observation, or research (experiment); its attainment similarly depends upon continued effort, and is limited only by the natural faculties of each individual. Such are the two essential factors of success in every industry, and in farming they are as necessary as they are to an engineer or to a surgeon.

It is evident that skill cannot be taught. At the same time manual operations may be performed in two ways: the one, being the better, is termed the right way, while the other, being less efficient, is a wrong way. The instruction which teaches how to do work with the least waste of energy and time is manual instruction.

Unfortunately, few people distinguish between manual and technical instruction, yet technical instruction is quite distinct from manual instruction. Technical instruction would teach the reasons why work done in a particular manner should cause less waste of energy than doing it in some other manner. Hence it is evident that no amount of technical education alone would make a man a skilled artisan.

Let me take an illustration. By experience a woman may become proficient in all the manual operations necessary to the manufacture of a cheese; she is a skilled cheese-maker. Yet such a woman may be absolutely ignorant of the reasons why the operations she performs result in a good cheese. In such a case she is deficient in technical knowledge. Education which will supply this defect is truly technical education. On the other hand, let us suppose that, by attending classes, by reading, and by watching others make cheese (observation) a girl becomes imbued with a knowledge of all the principles of cheese making. Could she make one? No. She would lack skill, the manual ability which practice alone can bestow, and without which success is as impossible in every industry as it would be in cheese making.

If, then, skill and knowledge are both essential to success, how does it happen that so many farmers who started life with but little education have been so successful? Because, unconsciously perhaps, but none the less surely, while obtaining manual skill they have also obtained knowledge. Skill has come by degrees, and knowledge has followed slowly on the heels of manual dexterity. How? Chiefly as the result of observation, and from conversations with their fellow-men; partly by experiment, and still less, perchance, from reading, some farmers have acquired knowledge in addition to their skill. This it is which has enabled them to outrun their fellows in the race of life. But I challenge any one of them to say that their position has been attained simply by manual dexterity, or that they are not indebted to natural faculties of memory, of sight, of touch, or of smell, developed, perchance, long after the days of schooling, though they ought to have been first trained then.

Such has been the system of education of those who have succeeded in agricultural pursuits in the past. That the schooling of such men has contributed absolutely nothing to their success is the fault of the schooling. Did it attempt to discover manual dexterity? Did it ever train the power of observation? Was even the word "experiment," much less the reality, known? Who can answer in the affirmative? A little time well spent in acquiring the three R's, but much wasted in storing up useless facts, was the training considered suitable to enable men to cope with nature and nature's laws, to compel the vegetable world to yield her treasures, and to subjugate the beasts of the field to the service of man. What an ignoble training for a noble career.

It is not to be wondered at that, so trained, and having gained useful knowledge solely as the result of experience, men should now look askance at education. Yet the results of education and experience are the same.

Let us take a simple illustration. Two farmers think of buying a cattle food of whose use they have had no experience. One buys it, uses it, and trusts to luck whether it proves profitable or not, *i.e.*, he follows his previous habit of paying dearly for his experience, and in course of time finds out its value. The other follows the more modern system of seeking first instruction ; in other words, he asks his friends whether they have tried it, or he sends it to some expert to advise him as to its value and use, or he looks in the agricultural papers to see what strangers have written about it. No matter in which of these three ways he may obtain information, that information is to him technical instruction, for all technical information gained from the experience of others, come to one how it may, is technical instruction. Now the principle which governs our modern views of education may be briefly stated in the old saying, "Art is long, life is short." We cannot afford, like the first of these two farmers, to seek out each one of us, the principles which govern the universe. We must be content to accept much as proven, for we cannot hope to find either the time or the means to prove everything for ourselves. Indeed, why should we attempt to go over ground which someone else has travelled and reported on fully ? We live in a hurry, let us gather all the information possible, so that we may lose no time in the pursuit of that which others have found lead to failure.

This desire has resulted in the collection and classification of past experience in all and every industry, and the information so accumulated forms our stock of technical knowledge. By studying this accumulated experience, by close observation, and by experiment, certain truths are deduced which may be said, so far as can be judged, to be of universal application. These, if properly expressed, become universally true principles. Such, for example, is the simple statement, "Every plant requires phosphates," and the collection of these principles, with the facts upon which they are based, we term Science. As the late Professor Huxley truly said, science is merely common sense, or experience classified.

While I grant that no theoretical education can ever be so strikingly impressed upon the mind as is the actual result of experience—especially when that experience results in a considerable loss, as frequently happens, yet the very object of technical education is so to instruct men that they may avoid these losses, these dearly-paid-for bits of experience. Hence the man who asks what has been gained by technical education, fails altogether to grasp its primary and chief object. Really what one wants to know is, what would have been lost by those who have obtained technical instruction if they had been without it. If the knowledge had been obtained, as of yore, by experience, with its necessary failures, what would it then have cost ? Who can estimate the enormous price at which in the past farmers have bought their experience ? The money now spent in technical education is an insignificant widow's mite by the side of this incalculable sum.

THE FUTURE.

Having endeavoured to show the inefficiency of the education given in the past, and the evil results which it has led to, let me briefly outline what I think desirable in the future.

Having been engaged for some years as an examiner for several County Councils, as well as for the British Dairy Farmers' Association, I have come to the conclusion that the elementary and secondary education given in rural districts has been disgracefully inefficient, and renders many who would now be glad to benefit by technical instruction utterly unable to do so.

If, as I maintain, one reason for the partial failure of agricultural technical education has been the inefficient elementary and secondary education given in rural districts, it becomes evident that these are interdependent, and must be recognised as such. Unfortunately, this co-relation has not been recognised in the past, and its disregard is one of the main reasons why in educational matters we are behind those who are becoming our chief competitors.

We hear of an "educational ladder." It is a fiction. A ladder presupposes uniform steps. Are there any uniform steps in our educational system ? The elementary schools are conducted with utter disregard for the secondary schools ; the secondary schools stand aloof from the elementary schools and from the technical schools ; and the technical education committees have gone their way ignoring alike both elementary and secondary education. Then what a farce it is to talk of an "educational ladder." No such ladder exists in England, and until it does our educational system will not be satisfactory.

Elementary, secondary, and technical education are studied, spoken of, supplied, and controlled separately, and by separate bodies, having no consideration for each other, and a total inability to recognise their mutual dependence. Hence the system of education in England has been a failure, and must be remodelled. It is suicidal mania to treat the education of the nation piecemeal. What is wanted is one sound graduated scale of progressive education—a ladder, if you will, each step of which shall be as separate and independent as may be, provided it is equi-distant from other steps, and bound together into one useful whole by the two main supports—manual skill and technical knowledge.

Those for whom agricultural education has to be supplied, may be classified under two categories. The first includes all those who are yet receiving elementary or secondary education in rural districts, the second, those whose education, so-called, is finished—who have joined the body of workers.

For the future generation, a thorough reform of the whole system of education is imperative; nothing less will suffice.

The elementary education of the country must be made more practical, must be so remodelled as to draw out all the faculties of children. It must be more strictly delineated, and not allowed, as is the growing tendency of the age, to encroach upon secondary education. In my opinion it would be well if, as in many schools of France,* the subject of agriculture formed one of the primary subjects of elementary education in rural districts.

The secondary education of the country should commence where elementary education leaves off; the secondary schools being replenished with the best scholars from the elementary schools by a perfect system of scholarships.

It is quite impossible to expect that every rural district shall have its secondary school. These must be placed in the localities where they can secure the largest attendances of day scholars, but they should also be boarding establishments for scholars from districts where no secondary school exists.

The scholarship pupils would only form a portion of the scholars, and should be those whose parents were not in a position to pay for this secondary education.

Secondary education should be given in two stages—the first, general; the second, slightly specialised and destined to train for the higher education, whether that be professional or technical.

From these higher secondary schools the technical institutes of the country would be replenished with pupils.

Lastly, it is necessary, if progress is to be made in any industry, that there be a continual search after new truths, or, as it is now termed, "original research." Were it not for the ever-increasing stock of knowledge due to original research, education would soon become stagnant. Fortunately, there seems at present little chance of this. But it is imperative we should realise that success in every industry depends more upon original research and new discoveries than upon the most complete knowledge of what is already known. And though it is the habit at the present day to look upon research as no part of education, yet this is a mistake. Research is the spring from which the whole stream of knowledge arises, and the ultimate result of education is so to train a man that he may himself become a new source from which the living waters of knowledge may flow.

Those who come under the second category who are already workers among the agricultural classes, yet might benefit from instruction, especially from technical instruction, are of three classes. First, those who, not having sufficient elementary education, must confine their attention to manual instruction, and for whom such instruction alone is suitable. Such, for example, are the larger proportion of the pupils who attend migratory butter schools. Another class is composed of those who, possessing sufficient elementary and secondary education, need efficient technical instruction. These, who ought first to receive the care of technical education committees, have in the past been the very class most neglected. To them, for instance, a ten days' course of instruction in a travelling dairy school is utterly inadequate. What they need is at least a three months' course of combined manual and technical instruction. Such counties as do not possess an institute where this instruction can be obtained ought, by means of scholarships, to enable that technical education to be obtained in any institute outside the county where it best can be.

Lastly, there is a class—by far the largest—who could better benefit by technical instruction than any others—I refer to the farmers themselves. They possess to the full manual skill, combined with no small amount of technical knowledge gained from experience. Such men can have technical education placed before them in only three ways—by papers, by books, or by lectures. The agricultural Press and the agricultural Societies sufficiently supply the first two means. Why have the Technical Education Committees not utilised the third? To a certain extent they have, but how? They engaged young university men, utterly ignorant of both practical farming and even the results of agricultural experience, to give lectures to an audience whom they neither understood nor appreciated, and the whole system was a failure. And because this means of technical education was a failure when improperly conducted, it has been unduly neglected. I am of opinion that, if properly carried out, and men of experience and repute, both practical farmers and scientific men, were selected as lecturers, much might yet be done by its means.

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* I refer to the schools under the direction of the Frères de l'Instruction Chrétienne, and would like to see in England an elementary text book of agriculture, similar to the excellent one used in their schools.

Lastly, there is the instruction, which can only be given in the houses of individual farmers—one might almost call it personal help. This is often needed to enable men to overcome some difficulty beyond their own powers, a difficulty which often demands the assistance of the ablest expert. Such experts are placed at the disposal of farmers in several continental countries by their Governments.

We seem opposed to this course in England, but I doubt whether we have not lost, in the depreciation of some of our agricultural produce, a hundred fold the cost of supplying such skilled instruction.

THE KNOWLEDGE WANTED.

I have not attempted to lay down definite or even general rules as to the exact kind of knowledge which the agricultural classes most need. I am of opinion that if the faculties be trained, the means to this end are of secondary importance. That the study of science must occupy a prominent place in the higher education there can be no disputing, and though perhaps personally biassed, there can be little doubt that chemistry and botany will be always of paramount importance.

But putting aside detail, it is evident that those who control the education of the farmer, whether on a School Board, or Secondary Education Board, or Technical Education Committee, should be men who are specially qualified to direct such education.

However, let us assume that a competent committee exists. They will easily determine what technical education will be of most advantage—what it is desirable to teach. But unless their experience should prove different to mine, they will meet at the outset with a very considerable difficulty. They will find that in many cases it is not possible to give this desirable instruction because of the inefficient elementary education which the would-be pupils have received in the past.

Of what avail, then, is it to determine what is desirable technical education, if such education be not possible? Technical instruction is the last stage of education. It must be preceded by efficient elementary and secondary education. To try and graft it on to a stock deficient in these qualifications is useless, and worse than useless, for it brings discredit on what, if properly used, could be of the utmost value, and it wastes money, and time, and effort, which, if properly directed, would be of national advantage.

COUNTY COUNCILS AND PRACTICAL TRAINING IN AGRICULTURE.

By HAROLD E. MOORE.

Until the passing of the Local Taxation Act of 1890 which admitted of financial assistance to a very large extent being given to technical education; but little attention had been given in England to that question in connection with agriculture. Occasionally various Agricultural Societies had promoted dairy lectures and some had also organised agricultural experiments. With these exceptions, however, the only means of agricultural instruction available in England up to that time were Agricultural Colleges giving complete courses of instruction of a very thorough and scientific character. The oldest established of these colleges is at Cirencester, in Gloucestershire, which was founded in 1845. Its course of instruction extends to practical agriculture, estate management, forestry, agricultural law, building construction, book-keeping, chemistry, geology, botany, zoology, physics, mechanics, mensuration, land surveying, estate engineering, veterinary science, architectural drawing and carpentry work. The instruction in the whole of these subjects extends over a course of two years and the terms must be kept consecutively during that period. At the end of that time satisfactory students on passing the necessary examination receive the diploma of the college. The cost of this two years' training is about £300. Since the establishment of the Cirencester College others of somewhat similar nature have been founded which are also not dependent upon Technical Educational Grants. These include colleges at Aspatria in Cumberland, Downton in Wiltshire, and Hollesley Bay in

Suffolk. In addition to these colleges, all of which have farms attached; the University of Cambridge has lately established special agricultural training in connection with Downing College; the University of Edinburgh has similar classes and grants a degree of Bachelor of Science in Agriculture; while at the Yorkshire College in Leeds and at Bangor University there is also special training in the science and practice of agriculture.

A diploma gained through any of these colleges is obviously of great value to young landowners or those who may come to that position and wish to be thoroughly acquainted with the varied questions involved in the treatment of land; to land agents, who must possess a thorough and scientific knowledge; to all those who may be proceeding to take up positions of importance in relation to agriculture in India or the Colonies; and to those who may in the future be wishful of becoming professors in agriculture or in some of its allied sciences. The existence, however, of these colleges can be of but little value to the ordinary class of tenant farmer, for the education given is of too thorough and scientific a character; costs too large a sum; occupies too long a period; and is generally not sufficiently practical.

The importance of providing instruction for tenant farmers, or those who intend to join that class, need not be commented upon by me. It is generally agreed that agriculture is one of the most important industries of this country and it is further admitted that under existing circumstances, nothing but the most advanced and modern methods are likely to give any adequate return for the capital and skill necessary for working land. We thus not unnaturally find that those County Councils vested with large sums to spend upon technical education have been doing something nominally for the instruction of this class. We will discuss whether such expenditure is of a nature likely to produce the results desired; or whether the money expended could not produce better results if more practical considerations were considered.

Prior to the County Councils being invested with the control of the large funds provided by the provisions of the Local Taxation Act, 1890, grants were to some extent given by the Agricultural Department of the Privy Council in order to promote agricultural knowledge. These grants were given to assist dairy institutes in the counties of Buckinghamshire, Cheshire, Leicestershire, Suffolk, and Wiltshire; to defray the costs of agricultural and dairy lectures in various parts; and to assist in carrying on agricultural experiments under the direction of various agricultural societies. The total amounts, however, thus expended over the whole of England, but little exceeded £1,500 a year. The total amount expended for technical education by County Councils, under the provisions of the Act before-named, in accordance with the Government report issued in March last for the preceding financial year exceeded £660,000. It is impossible to state how much of this amount has been expended for professedly agricultural education, the returns included in this Government Report not being sufficiently detailed for this purpose. Every county, however, includes some department of agriculture or horticulture among the subjects given; and the methods adopted seem to have been one or more of the following:—

(*a*.) *Lectures upon Agriculture.*—These have been extensively given, but in the majority of cases do not seem to have been particularly successful, judging from the attendances that have been reported by Councils who have organised this work. Nor does it seem to me that such lectures extending over a long course, and perhaps only occupying one hour per week, would be of so much benefit or so readily attended by those younger farmers who would wish to gain the information given, as if the lectures had been given for a longer time and at shorter intervals, the course thus lasting, perhaps, only for two weeks in the place of ten times that time.

(*b*) *Dairy Instruction.*—This has been thoroughly useful, and has been most practically given, in many different parts, with most beneficial results. It will be recognised by many that the principal feature we have to look to for success in English agriculture, is in the extension of dairy farming on the arable system, and on the most improved principles. Every step, therefore, taken in this direction, may be considered beneficial and worthy of encouragement.

(*c*) *Agricultural experiments.*—These have been most wisely carried out in many counties, with useful and successful results well worthy of the comparatively small expense. All of the foregoing directions however have involved but comparatively small cost.

(*d*) *Establishment of Agricultural Colleges.*—Various County Councils have taken this step, at a very large cost. Over £10,500 was provided by two Councils only for one college in the South of England during the financial year, of which the accounts were given in the before-named Government Report. I contend that the greater part of the money expended in this direction has not been spent in such a manner as to give agricultural or horticultual knowledge of the most necessary and practical kind; and the object of my paper is to make certain suggestions as to how the instruction given can be made more practical and useful to a larger number of persons. But before discussing this point I should mention a fifth way in which County Councils have expended funds, viz.:—

(*e*) *Granting Scholarships*.—These have been given to enable persons to attend colleges either under independent control or those founded by the county. I suggest that in many cases at least, the sum so contributed has been almost valueless, owing to the method adopted for selecting those to be so assisted.

In order to determine the utility of the college instruction it is necessary first to consider what is the class of persons who would be benefitted by a higher knowledge of scientific and practical agriculture. These may be considered to be of two classes. First there are young men of 25 years of age or upwards whose fathers or other relatives are farmers, with whom possibly they have been living all their lives and gradually taking part in the practical operations of the farm with the view of becoming independent tenants. Such persons as these are too frequently ignorant of the scientific principles upon which farming is based; are unacquainted with book-keeping; have perhaps little knowledge of modern farming machinery or new crops; and are only acquainted with the agriculture as pursued in the one district in which they have been brought up. Secondly, there are those who have a desire to take up farming as a business, and who are financially in a position to be able to do so, but who have comparatively little or no practical training in farm work, and who not only want to acquire the knowledge desired by the class I have just named, but should also gain acquaintance with the practical details of work on a farm.

There are large numbers of persons within my experience of both of these classes who are wishful of gaining this necessary and practical knowledge. It is clear, however, that it is necessary that they should gain this knowledge in the shortest possible time, and consequently that the course of instruction given should only extend over those subjects which are essentially necessary and will be of practical value in the management of a farm.

The colleges recently started or subsidised generally attempt the same system as those of the older agricultural colleges named at the commencement of my paper. Thus, to complete the entire course of instruction will occupy a term of not less than two years. In order to see how this two years is spent, I will give the list of subjects in the syllabus of the college I have named as being subsidised by county councils to the extent of £10,500 in a single year. I arrange them under three headings. The first of these would be those necessary to a capable farmer; the subjects named in the second class I contend need not be necessarily studied by those whose time is limited and whose future work in life is solely to manage a certain area of land in the most profitable manner; and the third class are those subjects which can scarcely be considered to be questions upon which farmers need have knowledge.

NECESSARY SUBJECTS.

(a) *Practical Agriculture*, including constitution and improvement of soils, labour, systems of cultivation, theory of rotations, crop culture, seeds and their impurities, injurious insects, manures, grass land, rearing management and diseases of live stock, dairying, poultry keeping, market gardening, and bee keeping; (b) *Agricultural Chemistry*; and (c) *Book-keeping*.

SCIENTIFIC SUBJECTS.

(a) *Inorganic and Organic Chemistry*; (b) *Physics and Mechanics*; (c) *Hydrostatics*; (d) *Heat*; (e) *Botany*; (f) *Vertebrate and Invertebrate Zoology*; (g) *Animal Physiology*; (h) *Veterinary Hygiene*; (i) *Meteorology*; and (j) *Geology*.

SUBJECTS NOT INCIDENTAL TO FARMING.

(a) *Surveying, Levelling, and Mathematical Instruments*; (b) *Farm Engineering*; (c) *Estate Management*; (d) *Farm Architecture*; (e) *Agricultural Law*; *and* (f) *Forestry*.

Space prevents printing in full the various departments of the instruction on the scientific subjects, as I have done in the case of practical agriculture. The syllabus of instruction seems, however, to be complete in each subject.

In glancing through this variety of subjects, it is certainly not surprising that the period of instruction extends over two years. Nor in the case of those who desire complete instruction in the whole of the subjects named, do I suggest that a less course than two years would be practicable. No intending farmer, under ordinary circumstances of either of the classes before named, can afford the expense or time of so prolonged a course. To those who wish for that thorough scientific and practical knowledge on all the points above named, and who are prepared to pay the costs of acquiring such knowledge, there are already open those Colleges named at the commencement of my paper. Where, however, county councils are having large grants nominally for the purpose of giving a higher knowledge of farming to intending cultivators, it seems to me unjustifiable to arrange the instruction in such a form as is practically useless to them.

But there are also other objections to this complete work. The inclusion of so much scientific teaching must lessen the attention given to acquirement of practical knowledge. I might mention two cases within my own experience showing that this has been the case. Some time ago I required an assistant to take some part of the control of certain farms which came temporarily under my management. I selected a gold medallist, and the best student of the year, from one of the leading agricultural colleges. I found that in the direction of farming work, and in dealing with practical questions which arose, he was not nearly so efficient as another assistant whose experience had only been gained from being on an ordinary farm. My second illustration on this point is taken from experience in connection with the Swanley Horticultural College. I had formed the opinion that even here the teaching was too theoretical and scientific, and in order to encourage the consideration of practical questions, I provided certain awards to be offered each term for students in their last year for essays on practical questions. The best of these essays have come into my hands, and though full of ideas, in the opinion of the judges, with which I quite agree, the plans of management suggested for one year's work were financially impossible, and the probable results inaccurately stated.

Then the compulsory inclusion of so much scientific knowledge as a condition of qualification for a diploma which is too frequently insisted upon, may give an inaccurate idea of the knowledge of an unsuccessful student. Thus a man can be experienced both practically and theoretically in all the departments of practical agriculture and agricultural chemistry, but yet may find it difficult to get a knowledge of the abstruse matters involved in ordinary organic and inorganic chemistry; of the varied knowledge required in advanced botany and zoology; and of the scientific terms of geology. Such a student would thus too frequently be unable to secure any diploma from the college in spite of his having an accurate and thorough knowledge of practical and scientific agriculture in all those departments which would be of utility to him.

In order to make the instruction given more useful, practical and available for an ordinary farmer I would suggest additions to the present system of instruction. The colleges as now existing are thoroughly equipped for both scientific and practical instruction and there can be no possible objection to continue the full instruction, as now carried on for the benefit of those younger students, provided they are in a position to defray the costs of this instruction. It must be admitted that the mental training and knowledge given by such courses of scientific instruction must be of value even if they are not practically wanted by those students in the their after-life. In addition, however, to the work being thus continued for the benefit of younger students I suggest that instruction might also be given in the following departments in every case where a farm is worked in connection with the college :—

(*a*) *Dairy Instruction.*—This to be given either by receiving students for one month upon the farm or by organising travelling working dairies as now to some extent carried on.

(*b*) *Agriculture.* — A complete course of instruction should be arranged to cover every department of practical agriculture as named in the syllabus before quoted, this course to extend over one term. This term should preferably be arranged to extend over the winter months, this being the time when those who would benefit by such instruction, could best be spared from the actual working of farms where they may be engaged during the active farming months of the year.

(*c*). *Practical Farm Work.*—This should be a somewhat similar course of instruction, but for a term extending over the summer months only and coupled with more actual work upon the farm itself; being specially adaptable for those intending to take up farming as a business who have not already had actual experience in farm work.

(*d*). *Special Subjects.*—Then it would be of the greatest value to those who are now farming to have short courses of instruction on various special subjects extending over periods varying from a fortnight to a term. Among such special subjects would be market gardening, horticulture, bee-keeping, poultry rearing, the marketing of farm produce, book-keeping, or some branches of scientific knowledge which the student had a special inclination to study, or which would be of special value in the particular circumstances in which he might be placed.

(*e*). *Instruction to Labourers.*—At the present time, in spite of the large sums which are expended, but little of the technical education grant is spent in improving the skill and knowledge of the actual workers upon the land otherwise than by lectures. These latter can scarcely be considered effective. I suggest that upon such experimental farms as named courses of instruction should be arranged for our younger and more intelligent labourers. To defray the expenses of such education, and to reward conspicuous merit when it has been proved, seems to me a most desirable method for expending some part of these large sums which are intended to be devoted to agricultural education. At the present time those who are concerned in the management of farms know how extremely difficult it is to get any young men who are efficiently qualified in the various operations of farm work. At the present time there is no inducement for a young man to stop in our villages and to acquire a specially skilful knowledge of the usual manual operations. Moreover, even if there are young men who are anxious to do this, there are no means now available by which they can get the instruction they desire. I cannot therefore, but think that this is one of the most important departments in which our technical education funds might be reasonably used. Moreover, if instruction for this class were organised, in addition to instruction being given as to the best method of the accomplishment of operations required from manual workers upon an ordinary farm, there should also be such instruction given that would fit such men for getting a permanent maintenance upon a small holding. If such instruction could be universally given we should in a short time check to some extent that continual exodus from our rural districts of the younger men which is now so injurious to our national welfare.

Here then are five practical directions in which technical instruction may be of use and at a total expenditure of less than is now incurred. I do not wish to under-rate in any way the value of the work done by the colleges which have been founded in various counties Nevertheless if in conjunction with the education of those younger persons who now go to these colleges, the work is so extended that the existing teaching staff can also undertake courses of instruction named, there are many hundreds of persons who can beneficially avail themselves of instruction in these departments.

I should moreover point out that in those counties where no recognised college is subsidised, the whole of the instruction named can be given if only an experimental farm be acquired, involving but a comparatively small cost.

But in addition to finding funds for the establishment of such colleges as I have named, many County Councils do at the present time provide scholarships or allowances to enable those receiving the same to become students. The one criticism to which this system is open, arises from the method of selection of those who are to be so helped. In the place of this selection being partially or entirely guided by considerations as to the capacity or future livelihood of the persons concerned, or their special capacity to become capable farmers; the selection is based upon the results of examinations. These examinations in the place of being upon technical or practical subjects, are solely upon English subjects of an elementary character, and most frequently only open to those of a school age. As a result those entering for the examinations are frequently boys who have no chance of ever securing a livelihood from working the land, but who only enter for these examinations at the wish of their parents, who, upon their success, are thus relieved of expense of any further education for the period for which the scholarship lasts. As a result, I have seen some of the candidates who have been so supported by the County Council grants at the Swanley Horticultural College, and also at colleges elsewhere, who have but little idea of continuing, as a livelihood, the work in which they are getting a training at the expense of the County Council. Moreover, in not a few cases of this kind the interest which the student takes in his work is of a very inefficient kind.

If scholarships are to be given I would suggest that they would be more useful if available for those of more mature age who are anxious to gain special information, and who are not in a position to do so unless assisted by this grant. Such scholarships might even be useful if they were to be expended in sending abroad young men of practical agricultural knowledge, to gain elsewhere particulars of agricultural practice which might not be obtainable in England, and which upon their return they might impart to others.

In conclusion, I might point out that in making these suggestions the work that is being done upon the Continent in relation to practical agricultural education on the methods suggested, might have been mentioned. I might have referred to what I have seen in the practical schools and training farms in Holland; to the agricultural schools in Denmark; to rural education, especially in forestry, as given in Germany; and to the village agricultural schools of Austria. In view, however, of the international character of this Congress, other papers may deal with these points which I therefore do not notice.

I contend that agricultural instruction is necessary, and can be made practically useful by extending instruction in the directions named, and by the formation of further County Council training farms. If, however, some such means cannot be found by which agricultural education may be made more useful and practical than it is at present, then I suggest that the large sums now expended by County Councils, professedly for the benefit of our agriculture, could be used in rate aid, or in other ways more directly assisting our tenant farmers, and those who are dependent for their maintenance upon the cultivation of the soil.

Mr. A. J. BAKER (Leicester), in opening the discussion, said, in reference to Mr. Lloyd's paper, that there were some statements which, in his opinion, as the Secretary for Technical Education for one of the counties, were too sweeping, and the information was not up to date. There were now a score of County Council technical education committees which took a very close and a very active interest in elementary and secondary as well as technical education. With reference to the paragraph which said that the technical education committees engaged "young university men utterly ignorant of both practical farming, and even the results of agricultural experience"—if that meant all technical education committees, it was a most sweeping and untrue statement. Very few engaged young university men, and those who had been engaged were mainly appointed five or six years ago, when the technical committees first came into existence. He would like to suggest that Mr. Lloyd should send out a circular letter to the different technical education offices in the kingdom, asking for up-to-date information on the point. It would be a great pity that such a statement should be published all over the world.

Dr. N. BODINGTON (principal of Yorkshire College, Leeds) said he thought the reader of neither paper had fully appreciated the large amount that was being done for agricultural education in the North of England, especially by means of popular lectures. In Leeds, for the past five or six years, they had had a staff of four lecturers travelling about the three Ridings of Yorkshire and lecturing every evening in the week during the two winter terms, and the lectures were attended by ever-increasing numbers. They had scarcely changed a single lecturer from the very outset, and their lecturers had won the confidence of the farmers to an extent which did not substantiate the observations that had been made, that farmers were indifferent to scientific knowledge. Yorkshire had never taken a backward step. At the present time they were maintaining agricultural and horticultural lecturers; they were working dairy schools and establishing experimental classes; and the money thus spent on agricultural education was being thoroughly well used, and, he believed, it was producing a marked and practical effect on the agriculture of the country. He believed that in Durham and Northumberland the work was also being carried on with considerable success. If they looked for the causes of that success, he thought it would be found in the fact that they had been careful to appoint men as lecturers who had a practical as well as a theoretical knowledge of the business of farming. Another cause of their success arose from the fact that their lecturers had lost no possible opportunity of bringing themselves personally into relation with the farmers in the district to which they belonged. Wherever it was possible they had gone over the farmer's lands; they had listened to their difficulties and given them suggestions to overcome the difficulties; and thus they had built up a mutual confidence based on personal relations. One point in which they had been less successful was the question of systematic courses of training for farmers' sons. There were probably many causes for that. At present their students went for practical instruction out to certain farms in the district, but it was generally felt that the scheme would never be a complete success until they had a farm of their own. Another point on which Mr. Lloyd had properly laid emphasis was the absence of anything like a complete and co-ordinated scheme of secondary education. But the difficulties of introducing into rural districts a workable scheme of education was much greater than people sometimes supposed. It was difficult to find centres. There had not been any indifference on the part of the Yorkshire County Councils, either to elementary or to secondary education; they had done all they could to relate the different parts of education, but there had been little demand for the scholarships, which had been perfectly freely offered to farmers' sons. One point in Mr. Lloyd's paper he was not in complete sympathy with. It was a matter on which he (the speaker) wanted further light. A great deal had been said about the need of introducing agriculture into elementary education. If all that was meant was that the child's mind should be trained in observation by elementary lessons in science, he cordially agreed with it; but if it was really intended that they were to take children of 12 or 13 years of age, and make them into something of little specialists, if they were really intending to drop out the idea of education for that of "paying knowledge"—knowledge which yielded results—then at present he was not in sympathy with that, and he should be very glad to hear from someone who was in sympathy with Mr. Lloyd what precisely they meant by the introduction of agriculture into elementary education.

Sir EDMUND VERNEY, Bart., said that everybody in Buckinghamshire despised education. He did not know of a single man or woman in Buckinghamshire who had a reputation as an educational specialist, but he could name a great many who were known in the other direction. The two papers were agreed upon the point that elementary education was deplorably deficient. He thought a practical question to ask was: Who is responsible for our elementary education? In nine cases out of ten, the man who exercised more influence upon the question of education than any one else was the parson. The agricultural parson deteriorated every year—speaking broadly. He came to the parish with fresh ideas, with some impulses and hopes, but they gradually faded away. The parson rightly held the greatest influence in the parish, and he ought to be the moving spirit, but he felt there would never be any improvement there. Which was the next class responsible for our elementary education? It was the farmers; they were practically controlling the elementary education of the country. What was the feeling of the farmer about education? The Chairman of a School Board in Buckinghamshire, pointing to a labourer, said, "That man knows more than his master, and that won't do for us." Farmers are elected on the School Boards to save the rates, and for no other reason, and many of them were not ashamed to say so; if they said anything else they would not be elected again. That was how they were suffering in Buckinghamshire. How were they to meet it? They could not meet it with the parson; he was past praying for; but they could show the farmers that it was to their (the farmers') interest that the labourer should be educated. What they had to do was to squeeze the farmer up from below, they could not do it from above; they must begin from below and educate the labourers. It was to the pecuniary interest of the farmers that the labourers should know their work. There was no other profession in the world in which they so tried to keep the lower members of the profession down. It would be better for farmers and labourers alike when they could understand the scientific side of their profession of agriculture. The great complaint at the present time was that the labourers were leaving the rural districts. Of course they were, because, as education grows upon them, they begin to see the hopelessness of their future; they see their only chance is to go away. In the towns they found gymnasiums, libraries, and swimming baths. Was it any wonder they left the rural districts when every effort was made to keep them down! Why was not the Public Libraries' Act generally adopted? Where he lived there were four parishes touching each other, in each of which the Public Libraries' Act had been adopted, and there was some chance of the labourer begining to grow. Another reason for the exodus of the labourer from the country was that technical education had been aimed at the heads of those above him, and very little was given to him. In conclusion, he wished to express his sympathy with what had been said on behalf of the labourer, and he felt it was to the labourer they had to look to save the country from ruin.

Mr. D. T. COWAN (Hampshire County Council), referring to Mr. Lloyd's paper, said he thought it was a thousand pities the writer of the paper did not make himself directly acquainted with the various work that was going on in each county, or else study the various reports and Blue-books that indirectly bore upon the work. Some very sweeping statements were made in the paper, and these statements covered not only one county, but every county in England. The writer of the paper had said that one reason for the partial failure of agricultural education was the inefficient elementary and secondary education given in the rural districts, and the total inability on the part of the authorities to recognise their mutual dependence. That he thought was a very sweeping statement, especially when one considered the efforts that be believed every County Council in England were now making with regard to this very point. He knew that in Hampshire they were attempting to march abreast of others, and they did consider the correlation of elementary and technical education. There was not a single public secondary school in Hampshire which was not controlled by the County Council, and which did not receive both money and teaching aids from the Council. They also endeavoured to get the secondary schools to take an interest in the elementary schools by offering scholarships and in various other ways. That he thought was evidence that they were able to repudiate that statement in Mr. Lloyd's paper, and that there was an attempt on the part of some County Councils to bring about this desirable object of the correlation of elementary and technical education. Referring to the concluding remarks of Mr. Moore's paper, he would like to point out that one fault lying at the root of much of the indifference in all counties was the fact that the money granted by Parliament never had been fixed for technical education. He believed every county would be much more to the front in the matter of technical education if it were not for the fact that portions of the grant had been and were still taken for the relief of taxation. He maintained that notwithstanding the great hope they had with regard to secondary education, the work would have settled itself down very quickly indeed if they had had this grant tied down years ago for educational purposes. One of the speakers had asked what the feeling of those working in agricultural counties was with regard to agricultural education in the elementary schools. He himself thought it was hopeless to expect agriculture—if by that word was meant the form of agriculture which they were acquainted with at the Science and Art Department—to be taught to the boys in the schools. In standard IV.—the exemption one in most rural schools—it was far too early to attempt to do anything of the kind. But he thought that science applicable to agriculture, such as botany, geology, entomology, and so on, might be introduced into the reading books, the boys might be made to take an interest in the formation of the soil in the district in which they lived, and the teachers in the schools might make that a special subject so as to encourage the boys to know all about their own district. So far he felt convinced that agriculture could not be taught in either elementary schools or continuation schools, except as branches of the subject.

Dr. L. Reece (West Indies) said the West Indies were practically in a state of ruin. The ruin had come about just because of the want of that technical education which Mr. Lloyd and Mr. Moore had been advocating. The natural advantages of the islands are enormous, but nothing has been done to develop them. The old system of education had no connection with life work. Nearly everything a man did in the West Indies was connected with agriculture, and 75 per cent. of the population never had any other career. These colonies were absolutely being lost on account of the system of education that was being carried on there. If they wanted an analyst they generally took a young man from some English university, who had never seen a farm in his life, at any rate, so far as practical knowledge went. If he had to limit himself to making analyses it would be all well and good, but he went among people who knew nothing about science, and to whom half-a-dozen technical terms made them gape in wonder. That young man attempted to teach the farmers new ideas, to teach agricultural science in schools; and the result was ruin. In the case of an agricultural expert his income is assured by his salary. But the very life of the farmer, and of all who derive their maintenance from the farm, including purely agricultural communities—like the West Indies. A vast deal depends on the success of farming operations, and these, so far as this subject is concerned, on the education of the farmer, who controls the chief source of national wealth and the prime necessaries of life. This is why he had always advocated self-supporting demonstrative farms, under the direction of practical agriculturists in place of the usual experimental ones under the control of experts (theorists), as the best means of teaching what is known, and of supplying by object lessons, technical instruction to those engaged in cultivating the soil. Let the value of the expert as guide be tested by the same standard that is applied to the pupil (farmer), who is asked to adopt his methods and ideas, viz., practical financial success. All education is the process of growth that accompanies normal occupation. Such education begins normally in contact with nature—observation preceding reflection—the concrete technical education cannot but fail as to its object so long as:—1. Elementary schools turn out pupils by a system of modelling, and crush out all individuality; 2. Teachers in technical schools are above playing the role of assistants (not masters) to pupils. The elementary education of the schools was not at all adapted for building upon it this higher education. They could not build anything upon education; education was a growth, and they must have the roots and stem, and leaves, and fruits. It was nonsense to talk of teaching one thing in one school and one in another. Whether in England or elsewhere agriculture was the industry which was at the basis of national greatness. And he hoped that the men of influence in the room would so impress the value of these two papers on the Colonial Secretary, that he would do something for education in the West Indies, and thus save them from poverty.

Mr. T. S. Dymond wished to say one thing about secondary education in agriculture, and that was with regard to teaching farmers agricultural chemistry. He felt it was an extremely important subject, because the application of artificial manures was not the result of centuries of experience, and therefore farmers frequently felt the need of instruction in the science of agricultural chemistry. Now, some of the farmers in Essex, with which his work was connected, had been through a course of chemistry at the agricultural schools, and he was bound to say when he met those farmers afterwards he found their chemical education had done them little good. They were distinguished from those who had not studied chemistry by occasionally asking for a symbol or a formula, as if that was the end and object of all chemical teaching. What was wanted was not such a course as that laid down by the Science and Art Department, but a thoroughly practical course—a course especially dealing with the chemistry of bases, acids and salts, as applied to manures, and their effects upon the soil. A year's practical course of that sort, if properly worked out, would do more good than the lengthy courses which were now given in some of the secondary schools and agricultural colleges. Consequently, he would like to point out, in cases where schools were helped by grants from the County Council, he did not believe those grants—so far as chemical education went at present—were always doing very much good.

Rev. R. C. FLETCHER (Lancashire County Council) said he did not propose to say anything upon the subject of Elementary Education, for the lamentable position of which in Buckinghamshire Sir Edmund Verney laid so much blame upon the parson; but he was rather pleased to hear that when the parson came into Buckinghamshire he came full of enthusiasm, so that it must have been the influence of the Buckinghamshire people that caused that enthusiasm to evaporate. His object in rising was rather to put before them the work which was being done in the county of Lancashire. He had had the privilege of being a member of the County Council and the Technical Instruction Committee since its formation, and was in a position to tell them something of the work carried on in Lancashire. Lancashire was generally known as a great manufacturing centre, but it was not always realised that it was also a great agricultural county. The amount of work done there for technical instruction in agriculture would compare favourably with that of any in the kingdom. Allocations of money were made by the County Council to the different districts. The district he represented contained sixteen townships, and received £490 a year. That money was expended upon lectures and instruction given chiefly in the schools in the various villages. But if that was all they did for agriculture, they would think it very little. They had other departments besides. The first was the County Agricultural School, which was held at the Harris Institute at Preston. The Harris Institute was established as a Science, Art, and Technical School many years ago, and was very liberally endowed by a gentleman who was long since dead. When the County Council took up agricultural instruction, the Harris Institute Council was approached, and consented to unite with the County Council in establishing an Agricultural School, and to utilise for this purpose the rooms of their institute and such lecturers and teachers as they had who were able to give the kind of instruction they wanted. Their next step was to get students, and with that view the County Council made an offer to the public at large, and especially to farmers and their sons, that any persons who desired to receive agricultural instruction, might come and attend at the Harris Institute for that purpose without paying any fee whatsoever. Not only that, but the County Council would pay the travelling expenses of such stndents; or, if they lived too far off to travel into Preston every day, they might lodge in Preston, and the County Council would make them a grant of 10s. a week to pay for their lodgings. At the present time they had fifty students in residence, and they were taught agriculture, mechanics, steam, chemistry, land surveying, veterinary science, book-keeping, and other subjects which were thought likely to be useful to them in their work as agriculturists. But the work of the lecture-room must be supplemented as far as possible by practical work on the land. Feeling that to be the case, the County Council became the tenants of a farm situated about four miles from Preston—a very good farm of about 170 acres, with model buildings upon it, and everything necessary to give a favourable start to the undertaking. They had somewhat added to the buildings, purchased a fine head of dairy cattle, and established a dairy school, with steam-power and skilled teachers, and they now offered eight weeks instruction free of charge to the daughters of farmers. During the eight weeks they were boarded and lodged free of expense, and received instruction in butter-making and cheese-making on the most approved principles, and they also had lectures on the chemistry of milk and the scientific part of dairy work. At the farm they had experimental plots for the testing of seeds and manures, in addition to the ordinary growing of crops, also a special department for poultry where they practised not only the ordinary feeding and breeding of poultry, but also incubation, cramming, and everything else they could. Cramming was a most disgusting operation, but when publicly exhibited it was always watched with great interest by the pnblic, and he believed it was a profitable operation. From time to time, the students from the Harris Institute were taken to the farm in order that they might see the practical operations that were carried out on the land. They also had a scheme of scholarships, and amongst these were three agricultural scholarships, offered every year and tenable for three years, of £60 per annum. These were not carried off by children. One of the first to win one was a man who had been for a year or two at the Harris Institute, but who, previous to that, had been a tenant farmer, and who was a married man with a family. He had since used his scholarship at Edinburgh, and was this month taking his degree there. In addition to what he had already told them, they employed lecturers to perambulate the county and address the public on various subjects connected with agriculture—poultry, bee-keeping, diseases of cattle, and so forth. Practical courses of instruction in butter-making and cheese-making was also given by skilled teachers at the cost of the country in any district that applied for them. They also encouraged practical experiments with regard to the potato crops and other matters, and the results were tabulated for the benefit of the farming community. Speaking for his own neighbourhood, he was able to say that though there was a very considerable emigration of the rural population into the towns, it did not take place owing to an inordinate love of baths (hot, cold, and swimming), public libraries, and gymnasiums; the whole question of the emigration of the farm labourer, so far as he know it, was simply a question of wages. In the country districts the farm labourer was half his time out of work. Rain came, and he was told, "You will not be wanted to-day," or there was a spell of frost, and he was told, "You will not be wanted during the frost." Consequently, the wages, which were always low, became less, and the man, in search of wages, left the country which he loved and went into the town which he abhorred.

Right Hon. Sir RICHARD PAGET said he had been more or less associated with all the earlier developments of the agricultural industry in regard to dairy work, and it was a matter of satisfaction to him to hear from various parts of the room evidence and testimony of the good work that was being done in different parts of England. The gentlemen who had spoken were engaged in the work, money had been placed at the disposal of certain County Councils, and they had produced a race of men not known before—those who were known as directors of technical education. Bnt where were the farmers, the very men it was their business to teach? They were not there! True, the yonnger class of farmers were men who were taking much more notice of scientific matters, but, still, it was a lamentable fact that the movement proceeded in a slow and sluggish manner, and it was because those whom they wished to benefit were slow to appreciate the benefits offered to them. He had listened to Mr. Lloyd's paper with the greatest interest. No one had a better right to be heard on the subject than Mr. Lloyd; he not only commanded respect on account of his scientific knowledge and acquirements, but he (the speaker) could speak in the highest terms of the ability which Mr. Lloyd displayed in the original research which he had conducted with such excellent advantage to the great industry of cheesemaking. They had had a discussion on elementary schools, which had not much to do with this subject, but so far as it might lead to children being taught certain elementary facts and natural results it might be beneficial. He was not for one moment suggesting that they should turn little children into specialists. No one in his senses would ever attempt to do that, but something ought to be done. It seemed difficult to get what was wanted, and one of the difficulties arose from the fact that teachers were too much in the habit of looking to what was too much of a necessity—would it pay? That was one of the things that required alteration, but it was by no means the only one. "I have come to the conclusion," said Mr. Lloyd, "that the elementary and secondary education given in rural districts has been disgracefully inefficient." The language was strong, but he (the speaker) was not prepared to say it was too strong. Mr. Lloyd had been actually engaged not only in the scientific, but also in the actual work of cheese making, and was in a position to form a very good opinion as to the true state of elementary and secondary education at the present moment.

Mr. H. MACAN said he felt it was his duty to controvert what Mr. Moore said. He believed in the whole course of his experience in educational matters he had never come across anything more deplorable than the final sentence of Mr. Moore's paper. Because a man differed from you upon the particular methods of teaching, because the style of teaching he adopted was not the same as yours, it gave him no right to make such statements. Whenever they entered the field of agriculture there always appeared to be certain persons who were anxious—he only knew one way of expressing it—to play to the gallery of the farmers by saying, what was the one popular thing with them, namely, "take education money" to relieve the rates. It would ill become him to make any comments on the paper of Mr. Lloyd, who was a distinguished authority on scientific subjects more particularly connected with agriculture. Mr. Lloyd had conferred immense benefits on the counties of Somerset and Devon, and his opinion on these matters would always carry the greatest weight, but Mr. Moore had not only gone out of his way to make the assertion alluded to, but the whole of his paper was a libel upon the work of the County Council. He was glad to hear from other speakers what had been done in certain quarters. Mr. Moore did not even know his facts, for in his paper he made this remark: "It it impossible to state how much of this amount (£660,000) has been expended for professedly agricultural education, the returns not being sufficiently detailed for this purpose." He (the speaker) could only say if Mr. Moore would undertake to spend a few hours in his company at 14, Dean's-yard he would be glad to give him that information. Mr. Moore went farther. In the earlier part of his paper he mentioned in a casual way some two or three educational institutions which had been started by County Councils, but he did not give the results of the institutions in Lancashire mentioned by Mr. Fletcher; he did not tell them anything about the work carried on in Reading; the work which was being carried out in the excellent farm established by the Cheshire County Council he did not even mention, nor did he mention the work carried out by the Sussex County Council at Uckfield; he said nothing about the Ashburton Agricultural School, or the new agricultural institution started by the County Councils in Cumberland and Westmoreland; he told them nothing about the work done by the Durham College of Science or the Yorkshire College lads, or the school with which Mr. Dymond was connected at Chelmsford; nor did he speak of the work which was being carried on in connection with cheese and dairy work in Somersetshire. Practically the whole of the important work which was being carried out by the County Councils was not even mentioned in Mr. Moore's paper. But Mr. Moore went out of his way to allude to a certain institution with which he (the speaker) was connected, but which he (Mr. Moore) did not mention by name, when he spoke of an agricultural college started by the County Council which cost £10,500. As a matter of fact it cost nearly £30,000, and it also cost £4,000 a year to maintain. But that was absolutely nothing compared with what their foreign friends would tell them was being spent on the Continent. The Duke of Devonshire said it was the proper institution for farmers to attend, the Board of Agriculture had voted them £150 and were raising it to £400, the Royal Agricultural Society gave its gold medal to one of their students, and yet Mr. Moore, told them the money which was spent upon it was wasted.

Mr. JAMES MASON said in Worcestershire their teachers of agriculture were not professors of colleges, but practical men. Poultry keeping was taught by a practical farmer who had made a special line of poultry; veterinary science was taught by a qualified veterinary surgeon in practice; the principles of agriculture were taught by a working tenant farmer; their cider making teacher was a man who went into the orchards and was present when the cider makers were making cider and perry; and butter making was taught by a practical dairymaid. With regard to the formation of more agricultural colleges and farms, he thought there was already a sufficient number, because the probability was that if the number were increased there would be a decrease in efficiency. The Worcestershire County Council did not propose to establish a farm, because they had numerous farms around them which they could select for special purposes. They also intended to utilise the farms already established by County Councils. They in Worcestershire were not giving theoretical instruction by theoretical persons, but were giving practical instruction by practical men. He might add, as an illustration of the practical value of the instruction, that a farmer formerly sent apples to market for which he obtained 30s., but, acting on the advice of the cider-making instructor, he made from the same orchard cider which realised £25.

Mr. J. SMITH HILL (principal, Aspatria Agricultural College) wished to add his testimony to the excellent work which the directors of technical instruction throughout the country were doing. Mr. Moore in his paper made reference to young men going to colleges "who are too frequently ignorant of the scientific principles upon which farming is based; who are unacquainted with book-keeping; have perhaps little knowledge of modern farming machines or new crops; and are only acquainted with the agriculture as pursued in the one district in which they have been brought up." He wished to bear testimony in the cases of students from Cumberland and Westmoreland, those who had received their education in the elementary schools and gained scholarships offered by the County Council, who did arrange for the "educational ladder" which Mr. Lloyd spoke of as wanting. He had been struck with the keen appetite for instruction with which such students, who had been selected by the directors of technical education, had come to the college,—some of whom he was going to say were hardly able to write their names, because since they left the elementary schools they had been engaged for five or six years in hard manual work on the farm—and who devoted themselves with the greatest enthusiasm to acquiring some of the technical knowledge connected with their work. It had given him, as a teacher, interest and encouragement in his work to see the way in which these young farmers benefited by the instruction which was now offered to them, and that they were able after so short a time to go and be a centre of light in their own district, spreading the information which they had gained, and which in time must benefit the whole of the community. He was speaking from close contact with young men who came from elementary and secondary schools by means of the scholarships established by the County Council, and he must bear record to the way in which the education was organised, and that agricultural labourers' and farmers' sons were easily able to obtain technical instruction. He would like to take exception to the statement made to the effect that some of these young men who gained these scholarships did not follow agriculture. His experience was to the opposite effect. The majority of those whom he met were now engaged in agriculture, and had not taken the agriculture scholarship simply to save their parents the expense of educating them for other occupations. Another remark of Mr. Moore's to which he took exception, and which did not do justice to agricultural colleges, was the following:—"I selected a gold medallist, and the best student of the year, from one of the leading agricultural colleges. I found that in the direction of farming work, and in dealing with practical questions which arose, he was not nearly so efficient as another assistant whose experience had only been gained from being on an ordinary farm." He (the speaker) thought it was probable that the medallist was only a young man, and had been selected soon after obtaining the medal, and he did not think it fair to the colleges—if his interpretation of his age was correct—that such a young man, because he had had technical instruction in the principles of his art at a college, should be expected to be able to manage at once all the practical details of a farm, and it was not fair at such a time to compare him with another assistant, who had perhaps gained his experience through many years. A speaker had referred to some of the courses at the agricultural colleges being too long. Two years was about the limit of time to which the courses could be extended, and he believed those who were engaged in teaching would bear him out when he said that the general course was not too long; sometimes they as teachers felt they should like an extension of the time. He hoped the time would come when technical education would be organised so well by the directors of education throughout the country that it would be the rule for every farmer's and every labourer's son to have the opportunity to pass a short time, after his general education was over, at an institution at which he would receive technical instruction in agriculture.

Mr. J. WHITEHOUSE GRIFFIN said he was a practical farmer from Buckinghamshire, and one of the greatest obstacles to teaching technical education in any form the County Councils had to contend with was the uncertainty of the grant. It depended entirely upon the vote of each County Council, and every new County Council that came into office might decide to make some other use of the money. If it was laid down by the Government once and for ever that the money was to be inalienable from technical education, they would know how to deal with it. With regard to secondary education, the great obstacle they had to contend with in the country was to find suitable places. The old grammar schools ought to be the centres in the country districts for carrying on secondary education, but he was sorry to say the trustees of those endowed grammar schools and the Charity Commissioners did not respond to their offers as they ought to do, and gave them no aid either in agricultural education, or technical education generally, except, perhaps, that they started a school of chemistry, but chemistry alone was of no use to agriculture. If chemistry was to be taught, it ought to be applied chemistry, and it ought to be carried out by practical object lessons. Although it had been laid down that they were not to touch upon elementary education, he should like to say that the reason that elementary education, as now constituted in the Code, was of very little service to the agricultural labouring classes, was that the teachers themselves knew little or nothing about agriculture. They did not know how to teach it, and, therefore, they ought to be well trained in the training colleges, so as to be able to teach the very simplest elementary work. Another reason was that it did not pay. Drawing was a subject that did not pay well, and was not taken up by elementary teachers. He felt that if they could get the elementary teachers to start with the labourers when they were boys attending the elementary schools, it would give a greater encouragement to those who took the labourer with his allotments, and endeavoured to teach him how to deal with them to the best advantage. The knowledge that came up from below would enable them to be more successful with their allotment schemes. In the county he represented they had been very successful in giving instruction as to the cultivation of allotments, but he could not help feeling that they were far behind other countries, and he wished they could have more information sent by the Board of Agriculture and other Government bodies to the County Councils, in order to assist them in this great work.

Mr. ALFRED H. BLUNDELL (chairman, Bedfordshire Technical Education Committee) said they had founded a technical agricultural school and farm in Bedfordshire, and he thought it would interest the meeting if he gave them a statement of one or two points connected with the working of the institution. He believed that this question of technical education, and the further development of anything connected with agriculture, was growing very much more than appeared on the surface. As an instance he cited the case of a man whom he knew in his younger days as the village blacksmith, who afterwards became a farmer in a village in Bedfordshire and took to dairying. His wife, knowing nothing about cheese-making, left her home and found a situation in a dairy in Gloucestershire in order to learn cheese-making, and having accomplished her object she returned to Bedfordshire, and now every year some eight or ten tons of cheese were turned out from that small farm. He thought that instance showed that there was a greater and wider interest taken in agriculture and dairy work than people sometimes thought. His Grace the Duke of Bedford had placed at the services of the technical instruction committee a farm of 274 acres, he had also built them a very admirable dining-room, a school-room, and dormitories for the students. They had made an arrangement whereby the County Council took 20 boys who had passed through the evening classes in the elementary schools of the villages, and who had been instructed by masters who had themselves some knowledge of agriculture. These boys had usually passed the fifth standard, and were from 16 to 18 years of age. They spent two years on the farm, and received board and residence, together with instruction. They did not find the students in clothes, but they gave them as rewards a small amount of wages every week, but money was subject to fines which were imposed in cases of abuse of the rules. There was a farm master who managed the whole of the farm work, a resident dairy mistress, with an admirable dairy provided by the Duke, and there was also a house-master and matron. The house-master took the boys in school every alternate day, and everything connected with the work of this farm of 274 acres was done by the 20 boys; only two or three labourers were employed besides. The teaching in the school had all to do with the necessary knowledge connected with agriculture. For instance, in their arithmetic and mensuration, everything was brought to bear upon what would be of use in the practical work in connection with the calculations necessary in farming and land measuring. They were also taught botany, the geology of the district, animal physiology, and any other subject likely to be of use to them in their practical work, and were subjected to an examination every year. The boys maintained the dairy under the guidance of the dairy-mistress. They had to do the milking; they weighed the milk, and kept a register for each cow. The making of butter and cheese, even the cleaning of the dairy, in fact, everything connected with the work of the dairy the boys did under the supervision of the dairy-mistress. They were also taught the management of poultry, and were privileged to witness the operation of "cramming." The directors tried to introduce on the farm everything connected with the work of practical farming, even to bee-keeping and market gardening. The place had only been established two years, and there would be ten boys leaving in October, and if there were any gentlemen farmers present who wanted some really practically turned out farmers he could strongly recommend the same.

Mr. MAURICE JACOBS observed that his object in rising was to say a few words for Buckinghamshire. He was anxious to do so because, although now connected with Bucks., he originally came from Sheffield. He had been connected with education all his life, but not with technical edncation; and he took great interest in the subject because he had worked his way up the educational ladder at a time before it was made as complete as it was now. He was invited to join the Mid-Bucks. County Council Technical Education Board, and he found on it many men who, if they were not eminent specialists, were at least gifted with energy, enthusiasm, and sound common sense, and even in apathetic Bucks considerable good had been done—much more than could have been expected. In a small village, Waddesdon, for example, having a population of 1,600, a course of lectures was given on poultry-rearing; the first lecture was attended by 142 people, and the second by 170. That, he thought, was a hopeful symptom. and showed that their work was appreciated. The parsons in the neighbourhood which he represented, at all events, were always giving them help on their local committees; they had never been a hindrance, but had always been of the greatest benefit. His evidence was perhaps worth all the more on this point because he was not a member of the Church of England, but a Jew. And he could safely say that they could always look forward to the clergy to help them in educational matters. Many agricultural labourers had told him that they were satisfied with their allotments, and felt they had a new object in life. The help the County Council Educational Board had given had done something to make the life of the agricultural labourer a happier one. He hoped the time would come when they would get swimming baths. His divisional Board were hoping at an early date to establish a domestic economy and a farming institute, and he hoped Sir Edmund Verney would persuade his division to co-operate.

Mr. R. P. WARD wished to make a few remarks on one part of the subject that had not received that amount of attention which its importance deserved—he teaching of dairy work. He came from Cheshire, a place which was perhaps rather noted for its dairy industry, and which had a County Council that had from the commencement devoted the whole of the money at its command to the purposes of technical instruction. In regard to instruction in dairy work, they had had peripatetic lecturers and formed classes in various parts of the county, and he believed they were the first to establish a fixed dairy institute, where students could be taken for some considerable length of time and given a thorough course of instruction, both theoretical and practical, in butter and cheese making, and they had come to the conclusion that peripatetic lecturers were very good to arouse interest, but that you could not get any very full instruction, particularly in regard to cheese making, in a short course of lectures; that if students were to get any really thorough instruction in cheesemaking, it was absolutely necessary that they should attend some place where the whole of their time could be devoted to the subject, both practical and theoretical, and that the courses should extend over some considerable length of time. Each year they became more and more impressed with the importance of the necessity of that, and at the present time, the committee that had charge of that particular duty laid it down that every person to whom they granted scholarships should stay at the institute at least ten weeks, and they did not allow anyone to enter for the examination unless they had attended that length of time. They experienced no difficulty in getting plenty of students into their institute. They had accommodation for sixteen or seventeen students, and the average attendance for the year had been eighteen or nineteen, they being often obliged to get accommodation outside. During the past year, out of the 75 who passed through the institute, 45 stayed for the maximum period; and three or four were so impressed with the benefits to be derived from the course that they entered for another course, and paid for it. The average attendance was eight weeks. They also tried to get farmers' wives and others to come for short periods of three or four days, or a week. In the case of a farmer's wife who was already a dairymaid, who came to get specific instruction on some particular point, a few days' instruction was very useful. Some remarks had been made in one of the papers that the persons who took advantage of these institutions were people who were well-to-do. That was not true so far as the county he represented was concerned. Among their scholarship-holders were a great number who were daughters of agricultural labourers. A course of instruction was also provided in order to train advanced students for becoming teachers if they desired. They further kept a record of all those who came to the institute and wished to go out as dairymaids, and they never recommended such unless they were perfectly satisfied with their work and conduct as students. The demand for the students as dairy-maids, or managers of dairies, was quite equal to the number they could supply. The majority of the students being farmers' daughters went away to improve the dairy products on their parents' farms.

Mr. LLOYD, in reply to the criticisms passed on his paper, said there was the highest authority for saying that those who are whole need not a physician. The people who had attended the Conference were the healthy ones, and they objected to the medicine he intended for the unhealthy ones. He was glad to hear that there was healthy and good work being done in some parts of the country, but they must not forget that if good work had been done under some Councils that did not represent the whole of England. When he was asked to read a paper he felt that it was impossible for him in twenty minutes to say one-tenth of what he wished to say, and he determined to be like the fisher, who stood by the stream, and threw a fly, which he had constructed as well as he could, in order that he might cause the biggest fish in the stream to rise. He felt he had succeeded in his object, and they must excuse him if he thought it necessary in making that fly to ensure that it was attached to a sharp hook.

Mr. MOORE, in replying, said, in reference to the remarks of Mr. Macan, that the figures quoted in his paper were from the Government Report issued only last March. Mr. Macan had suggested that he had ignored all that had been done, but the fact was that he found so much had been attempted that it would have been impossible for him to have mentioned all this work in his paper, and consequently he made no reference to it beyond stating the fact that in every county something had been attempted in the direction of agricultural instruction. He knew something of all those efforts Mr. Macan had mentioned, he was thoroughly acquainted with the work at Reading, he knew what was being done at Uckfield and the other places mentioned by Mr. Macan, but there were other institutes which had been even more successful and more practical. Mr. Macan had seemed to miss the real purpose of his paper, which was to make suggestions by which the instruction given could be made more beneficial to farmers than it was at the present time in numerous cases, where scientific teaching was alone attempted with funds supposed to be used for agricultural training. How successful such suggestions could be, if carried out, was shown by the representatives from Lancashire and Bedfordshire. In both cases the suggestions contained in his paper were stated to be there in operation. He therefore thought that instead of thinking their plans were perfect, it would be wiser on the part of some County Councils to consider the suggestions made, and see if their institutions could not be made more valuable and more practical by the adoption of some of them.

WEDNESDAY AFTERNOON, 16TH JUNE.

SECTION B.

Mr. JOHN WALTER SUGG, F.G.S., Master of the Clothworkers' Company, in the chair.

HOW BEST TO ENCOURAGE TECHNICAL EDUCATION AMONG TH WORKMEN.

BY R. W. BAXTER,

Teacher of Lithographic Drawing at the Bolt-court Technical School, London.

Before we can determine the best means o encouraging technical education among th workmen, it is necessary to be fully acquainte with the feelings of the men themselves i regard to it. Being myself actually workin as a lithographic artist in a printing-offic and as an instructor of lithographic drawin at a technical school, I claim to speak wit some experience on the subject, and the impressions I have thus gathered I will endeavou to set forth in this paper.

Ten years ago, the attitude of workme towards technical schools was positively hostil but happily this feeling has almost disappeare and it is gratifying to know that at the prese time it is much more favourable, notably i London. This is principally owing to th wise administration of the Technical Educatio Board of the London County Council; bu taking the country as a whole, it would be fol to assume that all prejudices have bee removed.

In the first place, there is still a fe among some that technical schools will ove stock the trade with workmen, consequent bringing down wages and increasing th unemployed, a feeling possessed by unionis and non-unionists alike, and which man fested itself very forcibly at a conferenc of the book, paper, and printing trade held at the County-hall, Spring-gardens, o July 4th, 1894. I shall not attempt here t either justify or confute this objection; it enough to know that the existence of th feeling is an obstacle to technical educatio and, as such, must be removed. I believe th conference referred to above, did much to confirm the opinion already held by many frienc of technical education; at any rate, the Londo Board have shown by their action that the fully realise the existence of this feeling b stipulating that only those actually engaged i the trade shall receive instruction in any of th schools subsidised by them; and, furthermor they have co-operated with the workmen themselves in the management of their own trac schools.

The Bolt-court Guild and Technical Scho of lithographic drawing, designing, an photo-process engraving, is managed by committee elected by, and from, the National Society of Lithographic Artists, and representatives of the Technical Education Board of the London County Council. The policy adopted by this committee is that only those who are engaged in the printing and photographic trades are admited to the school. Instruction is given to boys who are going to be apprenticed, but the committee decide what time shall elapse before apprenticeship. This policy of restriction has done much to gain the confidence of all in the lithographic and photo-process trades, with the result that the attendance at the Bolt Court school, amounts to about one-fifth of the entire number in the lithographic drawing, designing, and photo-engraving trade in London, a percentage, of which few other trades can boast, either in or out of London.

Secondly, there is a want of confidence in the efficiency of the teachers and in the practicalness of the teaching in technical schools. The prevailing idea is that the instruction given is "too theoretical." This difficulty can be surmounted (as it has been in London) by adminstrative bodies taking workmen's organisations into their confidence.

A committee composed of the chosen representatives of a trade organisation, and elected because they are known in the trade as competent men, must be in a better position to know whether the instruction being given at the school is useful and up-to-date, than a committee composed of estimable gentlemen who know nothing about the technicalities of the trade, but are simply patrons of the institution: one or two employers who, as a rule, know very little more; and perhaps a professor or two. I know for a fact, that committees of this description have been bitterly disappointed in their choice of teachers, as they are completely at the mercy of any charlatan who comes along. This cannot happen, to the same extent, to a committee of practical men, as their knowledge of the trade enables them to ascertain the capabilities of applicants with very little trouble.

In all cases where purely technical work is taught, the teachers should be practical workmen, in constant touch with every new development of his branch of the work. All classes where the work needs artistic skill should be under the general supervision of an art master. All classes where the work needs scientific knowledge should be under the general supervision of a science master. This would insure the work being kept up to a high intellectual standard, and would be the best method of combining sound instruction in artistic and scientific principles with the best practical training. That there is some difficulty in finding workmen with the capacity for teaching, I will admit. Nevertheless, such men have, and can be found, and there is no doubt that when technical education becomes a *sine quâ non* this difficulty will disappear.

In the lithographic and photo-engraving trades, improvements in the manipulation of the work are constantly being made by the workmen themselves. These improvements are often a long time before they become generally known, and consequently it is only the few who are benefited thereby. It is the duty of the teaching staff, to be constantly on the look-out for every new method of work, and to make the trade school a "university of the crafts." If this could be once achieved, we should hear no more of the teaching being "too theoretical."

Before apprentices can avail themselves fully of the facilities provided for them, some arrangement will have to be made with their employers, to allow them to leave business for at least two half-days a week, to attend the schools. Say an apprentice leaves business at 6.30 in the evening, and attends class twice a week for two hours; should they attend regularly for twelve weeks, they have only accomplished about a week's work. One day a week at least should be one of the conditions in every lad's indentures of apprenticeship, and committees of schools should be constantly pushing the point.

Finally, I should advise:—

1. That all technical education boards and like bodies, should negotiate with the trade organisations with a view to co-operation.
2. That all teachers of technical classes should be practical craftsmen.
3. That all classes should be under the supervision of professors of either art or science.
4. That strenuous efforts should be made to obtain more time for young apprentices to study at technical schools.

Could these suggestions be accomplished, I honestly believe that technical education would receive the united support of the community, without which it can never be that benefit to the nation which we so much desire.

TECHNICAL EDUCATION IN RELATION TO THE ELECTROTYPING, STEREOTYPING, AND PROCESS ENGRAVING INDUSTRIES.

By Walter Boutall,
Chairman of the Electrotypers', Stereotypers', Process and General Engravers' Association.

In reviewing the present position of technical education in connection with these industries, we are confronted with difficulties due to the want of anything like adequate organisation prevalent in the trades themselves. Until quite recently no Association existed which was entitled to speak with any approach to authority on behalf of the trades, and indeed their precise relationship to each other or to the more important industries with which they were allied was not clearly defined. Consequently, although the need for improved methods of workmanship, for stricter training of the operative, and for a general improvement in the standard of execution was felt among those mostly interested, there was no agency in existence for initiating any movement designed to improve the few facilities available for instruction and techical training in connection with the trades in this country. In this respect the process engravers are not now so badly situated as their colleagues the stereotypers and electrotypers, for in the absence of any trade organisation, the Technical Education Board of the London County Council has directly dealt with the question.

Much attention has been given to the various applications of electricity within recent years, and the production of electrotype plates for printing purposes has been considerably improved, but even now much is left to be desired. The stages leading up to the preparation of the mould, the production of the "shell," and the processes of finishing are all of them performed in an antiquated fashion. There is no real reason for this condition of affairs except the absence of a properly coordinated scheme of technical training. For want of properly trained workmen, advantage cannot altogether be taken in this country of methods and processes which prevail in the United States and elsewhere abroad, and the finish of printing electrotypes manufactured either in the United States or in some parts of the Continent, notably South Germany and Austria, is conspicuously superior to anything produced here. What is wanted is to train the English workman up to, at least, the level of the American standard. For the purpose of securing this result I think it will be desirable to establish properly graded courses of instruction, and if possible in connection with some recognised centre where special attention is given to the subject of typography. Such courses should include, as a preliminary, an elementary study of theoretical physics, the electricity stage being specially prepared with a view to the subsequent practical work; and later on a short course of applied mechanics; a period of practice in the use of machine tools with some knowledge of the construction of the more simple tools. I believe such a course would be appreciated by the men, and the knowledge that such technical training is available would confer an additional benefit upon the industry also, by attracting to the ranks of the workers in it, youths possessing the necessary qualifications, but who, at present, are hardly aware of the scope which it allows for the development of any special aptitude they may exhibit for the occupation.

No existing syllabus fulfils these conditions, the nearest approach is perhaps to be found at the Finsbury Technical College, but so far as I can ascertain, very few journeymen or apprentices have ever availed themselves of the teaching there; it was not sufficiently specific.

Candidates for the Honours stage in Typography at the City and Guilds of London Institute examinations are required to possess a general knowledge of the subjects of electrotyping and stereotyping, but no intimate acquaintance is pre-supposed with the details, nor is it necessary in the case of typographical candidates. Such papers constitute at present the only recognition of these subjects in any series of technical or technological examinations.

With regard to process work there is quite a different story to tell. In comparison with its age, probably no craft is at the present time so well provided with facilities for efficient technical instruction—at any rate so far as London is concerned. The numerous processes of engraving which are founded upon photography have all been introduced into this country within the last twenty-five years. For the first half of that period no substantial progress was made and the productions of English process workers compared unfavourably with those obtained abroad. The methods which involved a combination of lithography with pure photographic operations (such as collotype) were relegated to comparative obscurity—those which were capable of being used in conjunction with letterpress printing might, for their intrinsic merits, have shared the same fate but that a combination of circumstances compelled development. The two most important factors in determining this development were the great increase in the number of illustrated newspapers and magazines and the rapid spread of a general interest in and pursuit of photography as a pastime. The earliest workers in these letterpress printing processes were mostly French refugees who found an asylum here after the political troubles of 1871. These men in turn were set to train youths who were employed without any reference whatever to their aptitude for the somewhat delicate operations they were to perform. There was no selection, no recognised system of apprenticeship, no particular inducement was offered to the workman to efficiently teach his assistants, and in the result a number of workmen were engaged in the trade who had a rule-of-thumb method of working, but who had no acquaintance with the principles upon which the various stages of their work rested, and who consequently carried their performances to a certain level, but were unable to get beyond. To these succeeded a rather superior class, men who had been through a course in photography, at some one of the Polytechnics where the subject was taken, and so possessed the rudiments of a technical training. With the ntroduction of the more elaborate half-tone processes which were to supplement, and which are bidding fair to altogether supplant the old line processes, the need for more highly organised and more completely specialised training became pressing. While in the main one general idea was followed, in detail a very varied practice prevailed. Consequently much confusion arose whenever an alteration occurred in the *personnel* of the staff. A newcomer had probably been trained under different conditions and the employer frequently had to choose between preserving the traditional practice of his workshop, or adopting the innovations suggested by a more or less varied experience elsewhere. No test could be applied and the value of an innovation could be determined only by the result.

The rapidity with which the importance of he industry had grown, and the fact that many of the institutions which had originally devoted some portion of their energies to the ostering of a really efficient technical instruction in photography had found in course of ime that their efforts were, from lack of pure directness of purpose, calculated only to ncourage the amateur, induced the Technical Education Board of the London County Counci to take the matter in hand and to provide what should prove to be a really efficient technical school, working under conditions which should meet the requirements of the case. Premises in Bolt - court, Fleet - street, formerly used by the Stationers' Company of London for their day schools, were placed at the disposal of a joint committee composed of members of the Technical Education Board and of the National Society of Lithographic Artists. These were altered and adapted for the purposes intended and were fitted with a modern equipment of adequate capacity. Of necessity, the school was allied with art classes of the ordinary description. The class-teaching has been graduated so as to present a very comprehensive view of the subjects dealt with and is so arranged that the maximum number of students present does not exceed the number which can be properly dealt with at any one time. This limitation of number is always desirable; too little regard is paid to it generally in commercial or literary subjects, and in pure and applied science; but in technology its importance cannot be overrated for the constant contact between teacher and pupil is absolutely essential.

Besides the ordinary class-teaching, opportunity is afforded to facilitate as far as possible the progress of students by allowing those who have reached a certain standard to attend the school for independent practice.

Originally the classes were open only during the evening, but for the past eighteen months they have been also at the disposal of students during the day time; the fees are moderate, and are certainly within the means of any member of the trade desirous of joining the classes.

The complete course of instruction at present arranged deals with the production of negatives and positives for the various photographic processes, with the transfer of the image on such negatives so as to prepare printing surfaces; with the making of photo-litho transfers, and with the preparation of collotype films ready for printing. For the "relief" or letterpress process the work is continued through the various stages of etching and fine etching until the completed block is produced ready for the printer. At present the course stops short at this point, but it would be advantageous if room could be found for the necessary appliances to add to the equipment so as to secure a really sound training for those workmen in the trade who are engaged in the final operations of clearing up and mounting the blocks. This part of the business is at present somewhat neglected, and it might be arranged for as a special department of the work to be undertaken in connection with electrotyping. Although comparatively speaking a detail, it is yet a very important one, and in one's daily experience it not infrequently happens that blocks upon the preparation of which a great deal of care and attention has been expended are damaged, if not wholly destroyed, by careless mounting. Since the introduction of half tone work of finer grades than formerly prevailed, more delicate surfaces have to be handled, and the need of greater attention to this matter is imperative.

Notwithstanding the fact that the provision of adequate facilities must in this as in all other industries be a work of time, and that it takes a still longer time to impress upon the average English workman the benefit which he will derive in his ordinary daily occupation from attendance at a technical school, it is satisfactory to learn from the last report of the London County Council Technical Education Board that during the past year 97 individual students, of whom nearly two-thirds were actively and directly engaged in the process trade, joined these classes. The remaining 37 students, consisting of artists, lithographers, and letterpress printers, were also intimately concerned with the subject. The teaching is above all things practical and the amateur, as such, is sternly repressed. In the various departments into which the work is divided there were altogether 164 entries. Looking to the results obtained the cost of equipment and maintenance is extremely moderate.

Although London is the principal centre of the industry the influence of the school is likely to be far reaching, inasmuch as several firms have now established studios and workshops in rural districts, while the larger provincial towns are being gradually rendered independent of the metropolis by the opening of independent works or by the erection of branch establishments by the London firms.

It is frequently a source of complaint that the Polytechnics and schools for technical instruction in this country are not altogether in touch with those for whom they are intended. So far as I have been able to gather this is not the case with the school whose work I am now referring to, but the reflection occurs that to secure the greatest efficiency and to gain the confidence of a wider circle of operatives there should be associated in the control and direction of this school a number representative process-workers who wou possess greater authority than the Nation Society of Litho Artists. There are now London alone upwards of sixty firms and i dividuals engaged in the industry, and fro among them it ought not to be difficult to mak a satisfactory selection of governors.

In one direction there is need of and roo for immediate extension. So far as th manipulation of the mechanical details of pr cess-work for letterpress printing is concerne finality would appear to have been almo reached, but there is a tendency to try to pr duce more artistic results by combining wit the operations of the process-worker th methods of the wood engraver, and alread some very fine results have been obtaine There is some controversy as to how far this permissible, and without very careful trainin of the engraver for this special class of work may readily result in degeneration. Som provision then must be made for instructing f this purpose the large and increasing numb of engravers who have been pushed out of the own vocation by the encroachment of process work upon the field hitherto occupied by woo engraving.

Undoubtedly the most widely known and th most exclusively practised of all the processe are those which are based upon photograph but there are besides a number of automati processes which have either fallen into disuse or are only employed to a very limited exten As time goes on it will, no doubt be possible t include a practical instruction in some of thes as part of a general systematic course of tech nical tuition in process work. Also it may b hoped that at no very distant date, as th result of the work of this school, we sha establish as regular industries in this countr some of those extremely beautiful processes c chromo-collotype, which have been so success fully operated on the Continent, and by th Germans in particular.

Mr. H. J. POWELL asked if they were to understan that the classes did not attract the right class of me to them.

Mr. W. BOUTALL said he did not intend to conve that idea, but rather that at existing agencies in cor nection with practical electrotyping—for instanc the Finsbury Technical College—too much attentio was paid to this subject from the point of view c those engaged in general work in electro-depos tion, and too little from the point of view of th printer. He considered that the making of electrotypes for printing purposes ought to be treated as a special subject.

Miscellaneous.

THE GERMAN HOP TRADE.

Mr. Louis Stern, Commercial Agent for the United States, at Bamberg, in a recent report to his Government on the German hop trade states that hops are threatened by the competition of foreign countries, especially the United States, and no matter how great the industry and intelligence displayed in Germany, the enormous tracts of arable land in the United States are bound to secure the latter the upper hand in the end. The German hop trade may be divided into three classes. First of all there are the merchants who deal with the consumers (brewers) on the Continent generally; second, the merchants who deal with England on consignment; and third, the large breweries which buy directly from the producers. Twenty years ago German hops, together with the English product, ruled the markets of the world. At that time, however, the German hop trade, as it is to day, was dependant upon foreign countries on account of over-production. During the last thirty-five years Germany is said to have had only three bad harvests—1860, 1876, and 1882. Prior to 1860, there was, according to statistics, very little export from Germany to the United States and England. In 1860, Nuremburg and Bamberg firms began to turn their attention to the export trade. The Bavarian hop grower being the best situated, because he grows other products besides, does not enter upon anything but ready money sales. Brokers are very rarely employed. The merchants send their buyers, who sometimes spend several weeks at one place, particularly if there be any tendency to a fall in prices, for the German hop grower lacks the advantage of a review of the general position of the market, although with the telegraphic service of to-day, it could be as easily obtained as is a review of the wheat and flour prices of the world's market by the baker. The German hop producer likes to sell at three periods—September, October, and November. Only in Alsace does the hop grower make his contracts for the autumn and winter as early as spring, in order, as he says, to secure for himself a good price, if possible. Alsatian hops, being less in demand, do not prove so profitable to the grower as the Bavarian hops. In Bohemia, the principal hop-growing district is Saatz, and there the highest prices are to be met with, because the hops grown in that district are all sent to Germany. Auscha, the other hop-producing place in Bohemia has but inferior qualities, and these are sent to England and Scandinavia. France buys foreign hops for the better classes of beer, while inferior hops are produced in the northern part of the country. California has become the chief competitor of the German hop exporter, and forced by American competition the German hop producer has to content himself with a very small profit, and while his business may still be a sound one, there is no doubt, says Mr. Stern, that it is on the decline. America still consumes certain qualities of German and Bohemian hops because there is a great deal of German beer brewed in the United States, but even for this German beer American hops are chiefly used nowadays. Russia also was at one time an important consumer of German hops. In Russia beer drinking is not much on the increase, it is true, but still the consumption of hops is considerable. Now there exists a Russian Association for hop culture, which has had good Bohemian plants imported into Volhynia and Poland, and already there is a large surplus for export. For all that, Germany continued to export large quantites of hops to Russia until the Russian Government began to bar the way by raising the duty from 5s. 6d. to 27s. per poud. (Poud = 36 pounds avoirdupois.) This was at the time of the tariff war between Germany and Russia, and German hop export was at once at an end. Only two years ago was the duty on hops lowered again by the Russian Government, which caused the German export to recover itself, atleast to a certain extent. As for the rest the German hop trade seems to be able to hold its own only by the want of money of many of the breweries. The hop trade represents pre-eminently the spirit of enterprise, and it may be said that all the rich hop merchants, not only give extensive credits to the private brewers and small companies, but assist them with cash. This is done at a cheap rate—at 4 to 5 per cent. on mortgage or very often against note of hand alone. Actual usury is of very rare occurrence in such cases, for it is clear that a hop dealer can only reckon upon a large income every year if the brewing business flourishes, and not if it is undermined. This relation of the German hop dealer to the brewer explains at any rate the fact that even in years of high hop prices (as in 1894) the foreign product could only with difficulty obtain a footing in the German market, though it is only fair to state that in that year a considerable quantity of American hops was sold to Germany. In conclusion the Commercial Agent says that as regards the decrease of the export of German hops to the United States, the statement is borne out by the statistics of exports, and interested persons are of opinion that the American brewer will gradually get used to the American article, and that the German hop export to the United States, which is still fairly important, will cease altogether.

COTTON SPINNING AND WEAVING IN JAPAN.

Cotton spinning and cotton weaving in Japan, by steam power, are comparatively new industries.

Cotton spinning was first introduced at Kogoshima, by Prince Shimazu, at that time Daimyo of the province, during the Keiwo era (1865-7). The spinning machinery then introduced from England consisted of 6,000 spindles, and the object was to give employment to the *shizoku* retainers of the clan. Mr Robert Porter, formerly superintendent of the eleventh census of the United States, who has recently been investigating the condition of the various Japanese industries, says that some years afterwards another factory was opened by Prince Shimazu, in Sakai, Izumi province. In 1880, a similar factory was started in the vicinity of Tokyo. The latter venture is now known as the Takinogawa Cotton Mill. At that period the object of the mill owners was to replace hand labour by machinery. Their object has been almost accomplished, for there is now very little, if any, hand-spun yarn on the Japanese market. Between 1867 and 1877, cotton yarn represented 35 per cent. of the total imports into Japan. The Government then purchased various spinning machinery from England, which the authorities disposed of to different people who were given special facilities for repayment. Thus an impetus was given by the Government to the cotton-spinning industry, and the result was so far successful. During 1887, the quantity of cotton yarn imported into Japan was 63,252,924 pounds, but the imports were reduced to about 19,300,000 pounds in 1895, and a little below that in 1896. It is stated that in 1896 there were in the country sixty-seven mills with 607,505 straight spindles, 86,404 slanting spindles, and an additional 453,136 spindles soon to be put in operation, making an aggregate of 1,147,045 spindles. The rapid growth of the industry is well illustrated by the fact that at the close of 1894, only fifty-nine mills were in operation with 523,696 spindles. The straight spindles produce an average of 106 *momme* (about fourteen ounces avoirdupois) of yarn per spindle per diem, while the slanting spindles average 33 *momme* (about 9¾ ounces avoirdupois) per spindle per diem. The number of male operatives in the factories range from 13 to 1,087, the total being 10,531. The female operatives range in number from 31 in the smallest factory to 3,732 in the largest, the total number being 33,452. The horse-power of the machinery aggregates 15,595, the average consumption of coal per horse-power being 3,498 pounds per hour. That the cotton-spinning industry has been profitable may be imagined when it is stated that several new companies were formed last year, and it is asserted that before the close of 1897 there will be fully 1,500,000 spindles in operation in Japan. The wages of cotton-spinners in Japan are very low. Probably the highest are received by the operatives in the Tokyo mills, where the average for men varies from about eightpence to elevenpence per day. One of the most interesting features of the industry is to be found in connection with the exportation of cotton goods. Among the fabrics exported are white cotton piece goods, ribbed or corded goods, black dyed goods, cotton, flannel, towels, shirtings, &c Of the above, white piece goods, black piece goods and cotton cloths called *futako* fabrics are chiefly manufactured in the Yama and Owari provinces, and in the city of Himeji; ribbed or corded goods come principally from the Tokyo and Yamaguchi districts towels from Kobe and Osaka; cotton flannels from the Izumi, Kawachi, Kyoto, Iyo, and Awa districts cotton shirtings from Osaka, Tokyo, and Wakayama The corded goods and cotton flannels are exported in much larger quantities than the remainder.

Obituary.

C. Remigius Fresenius, Ph.D.—Dr. Fresenius honorary corresponding member of the Society of Arts, died on June 10 at his home in Wiesbaden, in the seventy-ninth year of his age. This great analytical chemist had been settled at that town for over fifty years, and his labours in the cause to which he devoted his life since his studentship in Bonn, in 1840, were incessant. He was born at Frankfort-on Maine in 1819, and as early as 1841 his researches were published at Bonn under the title of "Anleitung zur qualitativen Chemischen Analyse." In 1841 he left Bonn for Giessen, where he became an assistant to Liebig. Subsequently he published his Textbook of Quantitative Analysis, which went through six German editions. Sixteen German editions were published of the Qualitative Analysis, and translations of both works have appeared in most of the European languages. Dr. Fresenius wrote a large number of papers in scientific journals and transactions, both alone and in collaboration with other chemists. He was also editor of the "Zeitschrif für Analytische Chemie."

General Notes.

Coal Production of the United States in 1896.—The production of coal in the United States in 1896, amounted to 190,639,959 short tons, valued at £39,150,000, against 193,117,530 short tons valued at £39,560,000 in 1895, a decrease of 2,477,57 short tons in amount, and £410,000 in value. The decrease in product was entirely in that of Pennsylvania anthracite. The output of bituminous coa shows an increase of about 1,750,000 tons. The anthracite product of Pennsylvania decreased nearly 4,250,000 tons. Among the important bituminou coal-producing States, Pennsylvania stands first, with an output of nearly 50,000,000 tons. Illinois i second with nearly 20,000,000 tons, or more than 75 per cent of the combined product of West Virginia and Ohio, which comes third and fourth respectively The race between Ohio and West Virginia was very close in 1896, there being but 1,000 tons difference and the output of each nearly 13,000,000 tons.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

PRACTICAL EXAMINATIONS IN MUSIC.

The practical examinations in Music were not concluded this year until the 10th July, too late for the results to be included in the Report of the Council.

The system of examination adopted last year has been continued for the present year. Candidates are asked to select for themselves which of four standards they choose to be examined in. Standard I. is easy, Standard II. moderately difficult, Standard III. difficult, and Standard IV. very difficult. For each standard a list of music is given, and a selection from this list is sent to the candidates six weeks previous to the examination. Candidates are expected to play or sing pieces from the selected list, as well as to play a piece, or a portion of a piece, at sight.

In all 392 candidates entered, 13 of these took up two subjects, so that there were 405 examinations. Of these there were 361 passes and 44 failures. The following were the subjects taken up :—Piano, singing, violin, viola, mandolin, clarinet, and organ. 284 entered for the piano, of whom 257 passed and 1 obtained a medal; 54 entered for the violin, of whom 49 passed and 2 obtained medals; 2 entered for the viola, both passed and 1 took a medal; 1 took a medal for the mandolin; 1 entered and passed for the organ; 60 entered for singing and 51 passed, 9 obtaining medals; 1 entered for the clarinet, but failed.

Mr. John Farmer, of Balliol College, Oxford, and Director of the Harrow Music School, acted as Examiner, Mr. Ernest Walker, M.A., Mus. Bac. Oxon., and Mr. Burnham Horner, as Assistant-Examiners.

SECTIONAL COMMITTEES.

At the meeting of the Council on the 13th inst., the following committees for the Indian, Foreign and Colonial, and Applied Art Sections were appointed :—

INDIAN SECTION COMMITTEE.

Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I. (Chairman of the Council).
Sir Steuart Colvin Bayley, K.C.S.I., C.I.E. (Chairman of the Committee).
Sir Frank Forbes Adam, C.I.E.
Sir G. W. Allen, K.C.I.E.
Lionel R. Ashburner, C.S.I.
Jervoise Athelstane Baines, C.S.I.
Sir Charles Edward Bernard, K.C.S.I.
Sir M. M. Bhownaggree, K.C.I.E., M.P.
Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D.
H. M. Birdwood, C.S.I.
Lieut.-General Sir Andrew Clarke, R.E., G.C.M.G., C.B., C.I.E.
Sir Charles H. T. Crosthwaite, K.C.S.I.
Rt. Hon. George N. Curzon, M.P.
F. C. Danvers.
Sir Juland Danvers, K.C.S.I.
Sir Charles A. Elliott, K.C.S.I.
Major-General Sir Frederic Goldsmid, K.C.S.I., C.B.
J. P. Goodridge.
Lord Harris, G.C.S.I. G.C.I.E.
Sir William Wilson Hunter, K.C.S.I., C.I.E., LL.D.
Sir John Jardine, K.C.I.E.
W. S. Seton Karr.
Sir Seymour King, K.C.I.E., M.P.
W. Lee-Warner, M.A., C.S.I.
Sir Roper Lethbridge, K.C.I.E.
Sir James Broadwood Lyall, G.C.I.E., K.C.S.I.
Sir James Lyle Mackay, K.C.I.E.
J. M. Maclean, M.P.
General J. Michael, C.S.I.
J. Sewell Neville.
Field-Marshal Lord Roberts, V.C., K.P., G.C.B., G.C.S.I., G.C.I.E.
Alexander Rogers.
Sir Douglas Straight.
Thomas H. Thornton, C.S.I., D.C.L.
Sir Charles A. Turner, K.C.I.E.
Sir Raymond West, K.C.I.E.
Sir Alexander Wilson.
Arthur N. Wollaston, C.I.E.
W. Martin Wood.
Andrew Yule.
S. Digby (Secretary).

FOREIGN AND COLONIAL SECTION COMMITTEE.

Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I. (Chairman of the Council).
Sir Chas. Malcolm Kennedy, K.C.M.G., C.B. (Chairman of the Committee).
Lord Belhaven and Stenton.
Lieut.-General Sir Andrew Clarke, G.C.M.G., C.B., C.I.E.
B. Francis Cobb.
Sir Daniel Cooper, Bart., G.C.M.G.
C. Washington Eves, C.M.G.
Sir Malcolm Frazer, K.C.M.G.
Sir Douglas Galton, K.C.B., D.C.L., F.R.S.
J. G. Gordon.
Major-General Sir William Henry Rhodes Green, K.C.S.I., C.B.
Sir Robert G. W. Herbert, K.C.B.
Sir Villiers Lister, K.C.M.G.
Admiral Sir Erasmus Ommanney, C.B., F.R.S.
Sir Westby B. Perceval, K.C.M.G.
Sir Saul Samuel, K.C.M.G., C.B.
Sir Donald Smith, G.C.M.G., LL.D.
Gen. Sir John Stokes, K.C.B.
Sir Richard Temple, Bart., G.C.S.I., C.I.E., D.C.L.
Sir Charles Tupper, Bart., G.C.M.G., C.B.
Sir James Youl, K.C.M.G.
E. Cunliffe-Owen, C.M.G. (Secretary).

APPLIED ART SECTION COMMITTEE.

Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I. (Chairman of the Council).
Sir George Birdwood, K.C.I.E.. C.S.I., LL.D., M.D. (Chairman of the Committee).
Thomas Armstrong.
Charles Barry, F.R.I.B.A., F.S.A.
R. W. Binns, F.S.A.
Sir Courtenay Boyle, K.C.B.
Professor A. H. Church, M.A., F.R.S., F.C.S.
C. Purdon Clarke, C.I.E.
B. Francis Cobb.
Alan S. Cole.
Sidney Colvin, M.A.
Walter Crane.
Lewis F. Day.
I. Hunter Donaldson.
Major-General Sir John Donnelly, K.C.B.

APPLIED ART SECTION COMMITTEE—*(continued)*.

Sir Henry Doulton.
Hon. Sir Charles W. Fremantle, K.C.B.
J. Starkie Gardner.
William Gowland, F.S.A.
Sir Stuart Knill, Bart., Alderman.
Arthur Lasenby Liberty.
Sir Villiers Lister, K.C.M.G.
T. Buxton Morrish.
J. Hungerford Pollen.
Sir E. J. Poynter, P.R.A.
Professor W. C. Roberts-Austen, C.B., F.R.S.
Vincent J. Robinson, C.I.E., F.S.A.
William Simpson, R.I.
A. B. Skinner, B.A., F.S.A.
John Sparkes.
R. Phené Spiers, F.S.A.
Hugh Stannus, F.R.I.B.A.
H. H. Statham, F.R.I.B.A.
William Luson Thomas, R.I.
C. Harrison Townsend, F.R.I.B.A.
Sir Thomas Wardle.
H. B. Wheatley, F.S.A. (Secretary).

International Congress on Technical Education.

WEDNESDAY AFTERNOON, 16TH JUNE.

SECTION B.—*(continued)*.

JOHN WALTER SUGG, Master of the Clothworkers' Company, in the chair.

TECHNICAL EDUCATION IN CONNECTION WITH THE GOLD AND SILVER TRADES.

By W. AUGUSTUS STEWARD.

(Chief Instructor at the Central School of Arts and Crafts).

During Her Majesty's long reign considerable changes have taken place in the Gold and Silver Industry and the allied trades. Changes in fashion have been responsible for the growth and decay of several branches of the decorator's art, but changes in the methods of production have worked greater revolutions. Machine processes have been introduced which have materially affected both the makers of gold and silverware and the decorators thereof. Stamping and spinning tend to transform the smiths into fitters, while the press has been largely responsible for the partial decay of the art of *repoussé* and ornamental engraving. As a consequence entirely new systems of organisation and manufacture have taken the place of those obtaining sixty years ago. No longer is every part of a brooch, chain, casket, cup or vase made and decorated by hand, or does the average gold- or silver-smith feel himself capable of designing and making any article of jewellery or silverware. The introduction of machinery has almost changed the handworker into a mechanic, and by the sub-division and specialisation of labour is gradually transforming him into a unit in a large sectionalised factory, while apprenticeship for this and other reasons is practically dead. Hence the necessity for technical education. But the provision of technical education for these trades has been so slow and small that it is difficult to speak of it other than from the elementary standpoint. The first attempt to provide artistic and technical education on a large scale for the various workers in precious metals was made at the Vittoria-street branch of the Birmingham Municipal School of Art in September, 1890, the art department being controlled entirely by the Museum and School of Art Committee of the Birmingham City Council, and the technical room by the Birmingham Jewellers' and Silversmiths' Association, who were responsible for the fitting up and equipment. In the metropolis the attempts have been both meagre and badly organised. At the Regent-street Polytechnic a class for silversmiths was started in 1884, but was discontinued a couple of years later owing to the falling off of students, and the teacher's inability to give the necessary time. At the same school a class for goldsmiths was established, the first year that the City and Guilds of London Institute made goldsmiths' work an item in their syllabus. This was in 1891, Mr. Harry Stapleton starting and conducting the class with marked success, while for several years previous to this classes in *repoussé* had been running at the same school, at Alie-street, and Essex-house. The only attempt to provide specially applied artistic training for those employed in the gold and silver industry was made by the Goldsmiths' Company at a little school in Charles-street, Goswell-road, conducted by a German master named Meyer; but this has been dead for some years. This sums up the definite attempts made to give assistance to the young workers in precious metals before the advent of the Central School of Arts and Crafts. So that with the revolution in the methods of production, and a lack of artistic and technical training, it is not surprising that the crafts of the gold and silversmiths have not made the same progress as other artistic crafts, but now, through the establishment of the Central School of Arts and Crafts, at Morley-hall, Regent-street, by the Technical Education Board of the London County Council, and the Northampton Institute in Clerkenwell, the void is being filled, and opportunities offered the young workmen to improve themselves as craftsmen. Still it is essential to look back and find if possible, why those engaged in the industries under consideration have not taken advantage of the small classes started for their benefit or of the ordinary art schools. This can be largely explained by the inherent dislike of technical education exhibited by the older workmen, whose influence, acting on the lads, restrained them from entering the classes, but the theoretical character of the teaching, the fear of examinations, and the want of practical teachers in touch with the trade had much to do with the paucity of attendance. These and other causes will also explain why art classes have not been patronised. The system in vogue under the South Kensington authorities induced the teachers to urge the lads to undergo examinations, which always led along a beaten track, in order that the teacher could obtain grants by the pupil's success, little or no account being taken of the fact that the student desired his education to be of such a character as would make him a better gold or silver worker. The ordinary art schools taught a lad how to use his pencil, but the feeling was always uppermost in the minds of those who were anxious to improve themselves, and continued their studies notwithstanding the drawbacks, that they should have such a training as would fit them for the special trade they were following. This fortunately is now the feeling of some educational experts, who viewing the question from the artistic and technical standpoints, believe that the best results will accrue by allowing students to study art and design in relation to their own particular craft. But it is still difficult to induce the young craftsmen to attend the drawing and design classes. The antagonism of the older workmen has been broken down by the perseverance of some of those in actual touch with the men and their unions, while the youths are now more willing to attend trade classes, but the methods of the modern workshop have driven all idea from the minds of the average youth of the utility of even freehand drawing, their argument being that the draughtsman makes all the necessary designs and working drawings, and the craftsman's business is to work to the drawings supplied him. They fail to realise that a training in freehand will give them a better idea of line, and so enable them the more readily to realise the contour of the article they are called upon to make.

How then shall we induce the younger workers to undergo an artistic training? The only means I am convinced (by a long workshop training, and by intercourse with members of the trade when a student and now as a master), whereby drawing even in its elementary stages can be made palatable and interesting to those whom we wish to teach, is by giving them studies to copy which at once appeal to them by the fact that they, the sketches and models, exhibit some connection with the particular handicraft the lad is following. For instance, simple vases, boxes and the like for the silversmith, animal and floral forms, natural and conventional for the goldsmith, chaser, engraver, or carver. Once having interested the lads it will not be so difficult to induce them to study in a wider field. But the main question and the more debateable one, is the giving of practical instruction in the crafts. Various views are held as to which lines the classes should be organised upon. The workpeople and employers hold the view that the classes should be strictly restricted to those actually engaged in the trades, while others seem to think that it is the proper thing to turn out jacks of all trades and masters of none, on the off chance of finding a Cellini, or that unattached art students should be allowed access to the classes, so that having served an apprenticeship to art, they might apply it by acquiring a knowledge of gold or silver working, but, so far as London is concerned, the regulation of the Technical Education Board, which governs not only its own schools but all institutions which it assists by grants of money, declares that such classes must be strictly confined to persons employed in the trades taught. This, I venture to say, is a carefully thought out regulation which will, if adhered to, ensure the right kind of pupils and give them a greater interest in the schools.

Classes should not be established to supersede the workshop, but to supplement the training received therein. Viewed from the commercial standpoint it is largely a waste of time to teach the smith or spoon-maker to chase or engrave, or the chaser or engraver to do smiths' work; constant employment only can ensure such ability as will enable a workman to gain a livelihood, and it will rarely happen that an employer would, in these days of competition, employ men to move from one distinct division of a trade to another, and back again. From the artistic standpoint, or looked at as an acquirement of knowledge, it would not be labour in vain, but, as instruction calculated to enable a workman to gain a living by partly following a craft he can only learn by attending a school five or six hours a week, it would be misapplied. It will be argued that, given the opportunity, students will be found with such natural ability as would enable them to excel in several or all the branches of the gold or silversmiths' trade; this can readily be granted, but we must recognise the fact that there will always be a large number of persons engaged in the craft who will have to earn their living by working as units under the factory system, that is, if the mass of the people are to have jewellery and plate. It is forgotten that the art-craftsman can only appeal for his work and consequently his living to the select and monied classes, so that, while realising the possibility of raising some from the ordinary routine of the factory or workshop, we must not forget that the bulk of those attending our schools will have to continue under the factory system and turn out such work as will hold its own against all competitors. It is necessary, therefore, that the students should be enabled to make themselves more proficient in that section of the industry to which they are attached. From this it will be gathered that I am opposed, when viewing the question from the commercial standpoint, to the system prevailing at the Vittoria-street School in Birmingham, under which every effort appears to be made to induce the students to enter a branch totally different from that to which they are apprenticed or working at, instead of mainly encouraging them to improve their knowledge of the special branch in which they are hoping to gain a livelihood. For instance, a lad at Vittoria-street will be induced if he is a smith to learn chasing or engraving or *vice versa*. To those who understand how the trade is sectionalised this system is not a good one. The gold and silver trades are split up into various sections; roughly speaking the silversmiths are divided into seven sections—designers and modellers, large workers, small workers, spoon and fork makers, engravers, carvers, chasers and piercers, plate polishers and spoon and fork polishers; and between each group there is a more or less rigid line of demarcation existing. On the surface, engraving seems a small item to be so distinctly marked off as one branch but this is gradually being split into sections, and so we find monogram and heraldic hands or those who engrave inscriptions and cyphers only, here therefore much can be done to improve the knowledge of students in all the kinds of work to be done in this branch.

It would be difficult to enumerate all the articles coming within the province of the small workers, but with the modern methods of workshop organisation learners have little chance of acquiring the practice which would enable them to take a position with the feeling that they could carry out any job brought to them. Cases have come under my notice in both the gold and silver trades where lads have been so kept to the working of one article only that they have been practically useless when put to another job of a somewhat different character in the same branch. Amongst goldsmiths there are designers and modellers, mounters, setters, chain-makers, locket makers, makers of bracelets, ring makers and carvers, polishers, &c. Engravers, general carvers, chasers and enamellers, and besides the foregoing, there is a body of men who though working in gold and silver are classed apart from both divisions as watch-case makers and polishers. However, from the foregoing classification it will be recognised that both the gold and silver trades fall naturally under four main groups; the designers and modellers; the makers or smiths, who make up in metal the prepared designs; the engravers, chasers, carvers, enamellers, &c., who apply to the articles ornamentation of various kinds, according to designs prepared either by themselves or the designers; and finally the finishers and polishers who finish the work. These divisions at once suggest what, in the main, should be the work of technical education in the trade. The first and most important thing is teaching drawing and design, but, as I have previously pointed out, considerable difficulty has been, and still is, experienced in getting students to recognise this prime essential in an artistic craft, but I think if my suggestions are carried out, the difficulty would be considerably minimised. All members of the gold and silver trade should have access to the drawing classes, and if they would reap the full benefit arising from the establishment of technical schools, should study freehand and geometry, special attention being paid to plan and elevation, modelling, and subsequently design.

In the workshops students should be induced to make themselves thoroughly proficient craftsmen, and assisted to take up such work, in their own division, that they have few opportunities of practising in the workshop during the day. For instance, a gold- or silver-smith who has got into a shop where but a small selection of special articles is made would find it greatly to his advantage to study under a skilful teacher the methods employed in the production of other pieces. The engraver specialised as a "monogram" or "inscription" hand needs the opportunity to learn the other branches of the engravers' art, or that of enamelling, while the chaser, probably on "repair" work all day, would find it a considerable advantage to study chasing as an art, or to learn *repoussé*. There are a number of other ways in which help could be offered the craftsmen willing to improve their workmanship. The introduction of machinery, and the increasing uses to which stamping and spinning are applied, renders it essential that every effort should be made to ensure that the crafts shall not be depleted of those capable of actually "smithing" or hammering up a piece of work. To the smiths, therefore, and especially to apprentices and learners in this division, any opportunities to improve themselves in the art of getting out and producing their work by hand should find every favour.

I think it will be admitted that, with such a wide field in which to labour, the first aim of the technical schools should be to make a student thoroughly proficient in his own particular branch, and to use every endeavour to get him to understand the paramount importance of drawing and modelling, but this will not be found difficult if the right kind of men are selected as organisers and teachers, for the success of the classes will depend very largely on the teachers. These, in every case, should be practical men, with a thorough knowledge of their particular branch of the trade, and over these should be a master, with artistic and practical knowledge of the various branches of the industry. It is essential to the success of a school or class that the master and teachers should inspire the students with confidence and this I am convinced in technical schools can only be ensured by the appointment of the kind of teachers I have suggested.

I have endeavoured to place before you, as shortly as possible, what has been done and what I think is now required to ensure the success of technical classes in the trades connected with the working of gold and silver, and to those interested in the improvement and uplifting of one of the most ancient of crafts. I offer these few suggestions in the hope that the craft in which I have spent the best part of my life, and in which I am keenly interested, may benefit by the practical discussion and suggestions which I trust will follow my paper.

WATCH AND CLOCK MAKING.

By T. D. Wright.

Technical knowledge is, perhaps, more necessary to the watchmaker than to any other craftsman. The work is so minute that the uneducated eye does not see clearly enough, and, unless the workman engaged in one branch has some knowledge of the principles involved in the construction of the whole machine, and an intelligent appreciation of the duties of the parts made by others, he may waste days in the production of a beautiful specimen of manipulative skill which is wholly unfitted for the work it has to do.

In olden times, if a clever master had an intelligent, willing apprentice, the youth obtained a technical education of the best kind, and we are, no doubt, indebted to the apprenticeship system for most of the old masters whose productive skill obtained for us our reputation in horology.

The men, however, who, combined with practical skill, had the required scientific knowledge and the willingness to devote the necessary time to the instruction of their apprentices, were at all times few. Many young men finished their apprenticeship with but little more technical knowledge than they had when they commenced, and with practical skill in only the one narrow channel in which their employer had found their assistance the most profitable. The tendency was to train the apprentice in the way most likely to be directly remunerative to the employer, and, although this had the advantage of producing specialists who executed their own particular pieces of work admirably and quickly, and thus promoted an economical subdivision of labour which aided cheap production, it did not add to the ranks of the capable workmen who are always ready for unexpected emergencies, and who have the ability to adapt themselves to new designs and improved methods of construction. I think the failure of the apprenticeship system may be traced to the most flourishing days of the industry, for it was then that subdivision was carried to its greatest excess. It was no uncommon thing to find young men who had been engaged for seven long years in a sub-branch which could have been efficiently taught in as many months. As these branches were easily, and the most frequently overstocked, the young man had to direct his energies into some other channel, and practically to learn his business after he was out of his time. If, in his training, he had been taught to file and turn properly, and had that lightness of touch which can only be acquired in youth, and which is so necessary to the watchmaker, he would. after a time as an improver, possibly become a good workman; but many of the subdivisions did not give him this opportunity, and we need not be surprised that when the man had sons of his own to send out he was unwilling to submit them to the same unsatisfactory experience.

Even in the branches which give greater opportunities of obtaining knowledge, parents are not inclined, in these days of free education, to pay a money premium for the instruction of their sons, and when the premium is paid in service, the master has to repay himself for the time spent in instruction and experimental work, by directing the training of his apprentice, during at least part of the time, into some channel that shall be profitable, consequently the system of manufacture tends to run in grooves and ruts which limit the opportunities of the young man to acquire knowledge, and confirm the older workman in a machine-like course which resists change of any kind.

Free education and the necessity of carrying on business profitably are facts which we must adapt ourselves to. If the old forms of apprenticeship are not suited to the times we must remodel them. In a business like watchmaking some form of apprenticeship is absolutely necessary. The requisite skill and delicate manipulation can only be gained by practice and training. If we give up apprenticeship altogether we probably give up the trade. In some branches the term might with advantage be much less than seven years, and in all branches I am in favour of shorter terms, with an intermediate stage as an "improver," where the earnings of a young man will be proportioned to his skill and industry. If, during these probationary periods, he is able, after workshop hours, to improve himself in drawing, in mechanical knowledge, and in those branches of practical work which are directly associated with the one he is actually engaged in, he will be qualifying himself to become a master of his art.

The promoters of modern technical education recognising the wants of many industries, and attributing the shortcomings, at least in part, to imperfections in the apprenticeship system, sought by creating and encouraging sources of instruction outside the workshop to remedy the evils we suffered under. By studying what other nations had done they obtained valuable suggestions, and much good has been done. Time and experience are teaching us where the course adopted should be continued, and where it should be modified to produce the most beneficial results. In horology, as I dare say would be the case in other mechanical trades, although there was no active resistance to the new ideas, there was a passive obstruction, or an apathetic neglect which impeded rapid progress. The general feeling was that the movement was a good one, but too many of the trade stopped at that point and gave no real aid. Some employers encouraged their workmen and their own sons to attend the classes, and as the advantages gained manifested themselves, their example was followed by others. A few—very few—practical men had no faith in technical education, except that gained at the bench, while others were at first inclined to attach a value to theoretical knowledge which it did not possess. For instance, an employer in want of a good workman, finds among the applicants a young man who brings evidence of an intelligent understanding of his business, who has, perhaps, distinguished himself in a theory examination, and scarcely questioning him as to his practical ability engages him to fill the vacant post. If he has been fortunate in his selection, and the man is as clever at the bench as he was at his studies, and happily that often is the case, all goes well; but if on the contrary he is unfortunate in his selection, and obtains an indifferent workman who can neither work as well or as quickly as the workman who never studied at all, he decides that technical education is a mistake, overlooking that it was he who made the mistake in assuming that one quality necessarily implied the possession of another. These were the errors of the early days, but time is removing misunderstandings, and we all know now that although theoretical knowledge cannot take the place of practical skill, an intelligent assistant who has it can make better and more profitable use of his intelligence than one who has not been trained.

The young watchmaker cannot too soon learn that his very first qualification is the ability to execute his work well. If he studies he soon finds out for himself how much his progress is helped by a knowledge of the whys and wherefores, how much clearer he sees the path to take when a difficulty arises, and how much more interesting his calling is than he thought it was. To me one of the most pleasing results of technical instruction has been to witness the interest of the student when he begins to understand the nature of his business, and the keen appreciation with which he realises, as he progresses in his studies, that his occupation is not a mere drudgery but really an intellectual pursuit.

I do not think this feeling would ever be quite lost under the most adverse circumstances. It is not surprising that a clever lad should take pride in an occupation which has been so useful to navigation, and which requires for its proper understanding some knowledge of astronomy, of mechanics, of the effects of heat and electricity, and other natural phenomena. We frequently find that in addition to knowledge directly acquired, a desire is kindled for further study, leading sometimes to independent research and invention of importance, but always to an increased interest in the daily occupation. If the originators of technical education had done no more than to promote this affection for, and interest in, one's everyday work, we should have much to thank them for, but more material benefits have been gained. During the years that the classes have been conducted at the British Horological Institute, some hundreds of young men have attended, and I could point out many to-day who attribute their advancement in no small degree to the instruction they received there. In the other schools of horology conducted at the Polytechnic Institute, Coventry, Edinburgh, Aberdeen, and other places, I have no doubt similar experience could be shown. The consequence is that we have had, for some years past, a new generation growing around us. The relative values of the different branches of knowledge are better estimated because many of those interested in the matter have taken an active part in it. The good influence spreads beyond the pupils themselves, for it often happens that the son or apprentice may be able to make some suggestion, which proves to be an improvement, and which was prompted by his observation of what was being done outside his own workshop.

One important result of technical education I should like to mention, and that is the invention by Mr. Bonniksen of his rotary escapement, which has proved so successful at the recent Kew and Greenwich Observatory trials. Mr. Bonniksen was a student of the Horological Institute for some years, and during that time his natural ability and perseverance gained him considerable distinction; Breguet's tourbillon interested and attracted him, and in the course of his experience in timing and adjusting he saw how useful such a contrivance could be. But the cost and delicacy of Breguet's invention prohibited its general use, so Bonniksen set himself the task of inventing something on similar lines which should be strong enough to be carried in the pocket with no more risk of injury than an ordinary watch, and which should add little, if anything, to the cost. His "karrusel" watch is the successful result. About three years ago his perfected design was submitted to the trade, and many manufacturers consented to make up one or two as an experiment. If doubts of its success did possibly exist those doubts are rapidly disappearing. During the year 1894, a few were finished and sent to Kew for the usual trials. Seven obtained the "especially good" certificate. The Kew report for 1894 states: "The watches entered for the highest test, class A, have been decidedly above the average in quality, the number of these (46) obtaining the highest form of certificate (class A, especially good), being *considerably in excess of any previous year.*" In 1895, 27 out of 56 were "karrusels," and in the report for 1896 we find that 96 watches obtained "especially good" certificates, 60 *of which were "karrusel" levers.* In the recent deck watch trial at the Greenwich Observatory a "karrusel" lever heads the list, and a number of them, manufactured by various firms, obtained high positions. No horological invention in this country has had so rapid and pronounced a success.

I should not presume to claim this invention as a direct result of our efforts to promote technical education, if I had not received the inventor's own testimony. During its conception he assured me how much his technical training assisted him. His mechanical knowledge helped him in determining the proper proportion of the various parts, the relation between the motive power and the balance in the new conditions, and the possible effect of friction in the rather bold departure from conventional lines in the arrangement of his rotary carriage. His ability in drawing enabled him to complete his design on paper, so that he had no blunders to correct when he started the manufacture of the rough movement for the general use of the trade.

We watchmakers had almost reconciled ourselves to the belief that our art had attained the perfection of mechanism, that there was nothing to improve. Bonniksen has taught us that improvement is possible, and so long as 100 marks at Kew, or an O trial number at Greenwich is not obtained—and probably they never can be reached—or so long as a watch does not wind itself up and show itself independent of the eccentricities of its wearer, there will be room for the clever man to invent improvements.

I cannot pretend that the system of producing watches in England by machinery is an outcome of the technical education scheme, because machine construction preceded it, but that the promoters and conductors of successful machine factories possessed technical knowledge in a high degree there is no gainsaying, and that their success has been helped by the growth of technical knowledge I am sure. I believe that the highest grades of watchwork will always be produced by skilled hand labour, assisted more or less by machinery as it always has been, partly because the hand system lends itself more readily to changes and improvements in design, and partly because the machine cannot detect faults in material and construction as the good workman can. But there is no doubt that the general watch of the future is a machine-made one. Successful factories are now established in London, Coventry, Birmingham, and Prescot, and I am proud of the certainty that some at least of their productions, modelled on the best types of English hand-made watches, are the very best machine-made watches in the world.

The success of the machine factories need not alarm the young watchmaker, or cause him to fear that his occupation is gone. In the most perfect machine system a considerable amount of skilled labour is required, and the increased output of home productions will probably absorb more skilled labour than was ever required in the whole trade under the old systems. In springing and adjusting watches there is a want in the machine factories of competent workmen, and young men will be wise to perfect themselves in this branch. I am hopeful that the new Northampton Institute in Clerkenwell will shortly be able to offer assistance to watchmakers who wish for opportunities of improving themselves in this direction.

Clockmaking as carried on in London has some advantages over watchmaking for the apprentice. In the first place it is not nearly so subdivided, and the youth has a much better opportunity of making the whole machine, although it is not usual to quite do that. Then the work is so much larger that he sees and understands much better, and I think it wise to let the lad who is to become a watchmaker spend his first year in the clock shop. The general principles are the same, the methods of working differ in some respects, but the differences are instructive and help the training. I am speaking now of the ordinary house clock. The manufacture of turret clocks is on altogether different lines and would probably not be a suitable training for either the watchmaker or the maker of small clocks. But the broad principles of design and constructiou are on the same lines, and one of the purposes of technical education is to help the members of these different branches of horology to get more in touch with one another, and by studying each other's methods, to possibly obtain useful hints.

The manufacture of house-clocks is capable of great development in this country. In the near future, electrical clock-work must play an important part. Both of these facts should recieve due consideration from the trade, and from the technical institutions concerned, and some preparation should be made to supply the wants of our own country.

Technical education has of late years, and I think, rightly, tended more and more to include practical instruction in its syllabus. Technical councils, are, I think, fully alive to the fact that purely scientific education is likely to go over the heads of the majority of the workers, and fail in its usefulness. They welcome the assistance of the various trades concerned, in arranging their classes, so that they may be technical in the fullest and most perfect sense.

Mr. STEWARD asked if Mr. Wright did not think that the tendency of machinery as applied to watchmaking was to stereotype the class of watches produced thereby, owing to the expense of altering or laying down new machinery. Mr. Bonniksen was deploring the fact that several of the large factories did not take up with his epoch-making inventions on that account.

Mr. D. BUCKNEY thought there was not much in the paper which anyone could take exception to. Mr. Wright said there was no doubt that the general watch of the future would be a machine-made one. That implied that the hand-made watch must go to the wall altogether. He (the speaker) hoped that would never be the case, because the machine-made watch could not be looked upon as so scientific a time-keeper as a hand-made one. Mr. Wright had also referred to the apprenticeship system, but they might take it for granted that so far as watch and clock makers were concerned, apprenticeship was dead. It had never been satisfactory. One reason for the decline of the apprenticeship system was the fact that employers received a premium varying in amount, and as soon as they had received it the apprentices were turned over to the workmen, who received no consideration whatever for what they were teaching. Another reason was that the work that the apprentice turned out during the early years of his apprenticeship was practically useless to an employer. The theory work that was being taught now-a-days was of very little use unless it was followed up by practical instruction. It was sometimes found in examinations that the paper work was done like a book, but when they came to test a man's practical capabilities they were found to be not worth a rap—he would not be able to earn his salt. They had to look and see how the present state of things could remedied. Shortly, practical classes would be started of an evening in the Northampton Institute. That was all very well, and would no doubt be productive of a great deal of good to workmen who wished to avail themselves of the opportunies offered there to improve themselves. But something was wanted beyond that. How were they going to provide the best workmen of the future? He did not think it could be done by evening work alone. He thought it would be necessary to establish a system of day work, which could be done by scholarships and paying students. At all events, lads ought to have an opportunity of working a certain number of hours during the day at the practical part of the work, and the theoretical work must go hand-in-hand with it. It might be taken alternately in the evening, as a sort of recreation, with drawing and the study of physics, metallurgy, and several other kindred branches of science which were likely to prove useful. By that means, he thought, they would provide the trade with a certain number of actual workers. Mr. Wright had also referred to what had been done in the classes of the British Horological Institute, and he (the speaker) joined with him in the feelings of pride with which he viewed the success of the many students who had been trained there. They unfortunately had one difficulty, and that was that they had not been able to reach the actual worker. They wanted to produce men who were prepared and intended to earn their living at the particular branch to which they had devoted their attention, and he should have liked to hear a little more from Mr. Wright of what he suggested in that direction. It was, of course, difficult to take men trained under the old system and educate them to new ideas, and it was far easier and better to take the lad and work him up to do what was required of him.

Mr. Wright, in answer to Mr. Steward, said machine systems did decidedly tend to do away with the artist; but the machine system was not one to be followed by what he called a workman. That Mr. Bonniksen's invention was not taken up by the big factories he did not think need frighten either Mr. Bonniksen or anyone else, and for this reason, that the great difficulties machine factories had to contend with would always leave some opening for the hand-worker. The factories could not easily adapt themselves to a change, whether that change was an improvement or not. It was so difficult and costly to alter the plant in order to introduce anything new and decidedly good that the hand-worker for the time being would have that good thing all to himself, and that should be looked upon rather as an advantage to the worker, while watch making by hand was really a trade. There was no doubt that inventions like Mr. Bonniksen's would from time to time crop up, and it they were as good as his so much the better for the hand-worker that it was a difficult matter for the factories to adopt it. Mr. Buckney seemed to think that he (the speaker) suggested that the hand-trade would go altogether. He did not intend to suggest that; but he thought that probably 99 watches out of every hundred that were used by the ordinary public would be made by machinery, and he did not see why 90 out of that 99 should not be made in this country instead of being imported from abroad. He was pleased to see the success of some of the English watch factories. Those who were not in the trade and had nothing to do with watches had no idea how good they were, although they were a long way short of the watch Mr. Buckney referred to. He did not agree with Mr. Buckney in thinking that the system of apprenticeship was dead. He (the speaker) thought apprenticeship in some shape or form was really necessary in a business like watch making. His own idea was that a lad who was going to be brought up to the trade should be put for a year in a clock shop to make the tools and the smaller parts, and at the end of the year the boy or his guardians ought to make up their minds whether he is suitable for watch making; or if he is too heavy-handed for watch work, whether he is to go to clock work. He should then be apprenticed for three years. At the end of that time he would not be a finished workman, but he would be competent to take a situation as an improver, where his earnings would depend upon his ability. During all this probationary period he should be encouraged to attend technical classes which give instruction in drawing and in the mechanical principles concerned in his trade. The Northampton Institute was new, and the evening classes had to be tried, they had to find out the wants of the district; but if it proved eminently successful, there was no reason why it should not be turned into a day school, and become a school of horology, where young men could be taught in a proper manner the beginnings of their career, and encouraged to go on in the special lines which were best fitted for them.

Mr. Parker Rhodes said we were much too conservative in this country. Watches and clocks were most essential, and yet we were only using the timepieces and time indicators of former ages. There was absolutely no improvement: he admitted there was improvement in the mechanism, but there was no improvement in the construction of the dial of a watch or a clock. If they made the Government feel the necessity of giving support by small subsidies, there would be encouragement for those who were now exerting themselve almost fruitlessly over the task they had set themselves. Although so much had be done to improve the character of watch and clock making, there still remained a very large amount to be done to accomplish what we all desired, viz., a correct time indicator.

Mr. Alderman T. **Snape** (Liverpool) said the Technical Education Committee of Lancashire, at an early stage of their history as a committee, had sought to establish technical instruction with reference to an industry that at one time flourished in the county, but had since fallen into decay—the horological industry. A few years ago Prescot and Coventry were the two chief seats of the watch manufacture of this country, but at the time they came into possession of the funds the industry had fallen away, and they thought if by establishing a horological school they could revive that industry, and give back to Prescot the fame it once possessed of being the seat of the manufacture of the best watch movements in the world, they would be doing a good service to the county, as well as to that particular industry. The reason for the decay was owing to the fact that Americans had begun to manufacture watches by the aid of machinery, while the English continued to manufacture theirs by hand. In order to carry out the idea members of the committee visited the schools of horology in France, Switzerland, and Germany. They found a great difference between their system of technical instruction and our own. The system was a kind of school apprenticeship, and the scholars went from the elementary schools to these training schools. There they remained for four or five years, and were taught, practically and theoretically, everything connected with the manufacture of a watch, from the simplest process to the most difficult. In this way they succeeded in acquiring perfect skill in the construction of a watch, and before their four or five years term of tuition was over they were able to construct a watch from beginning to end. The result was that when they left their schools they were received as full journeymen into the employment of the various watchmakers in the country. One difficulty they experienced with their school at Lancashire was that they could not get their students to remain long enough, and another difficulty would have been that after they had completed their training in the schools the trade would not allow them to become journeymen watchmakers without serving an apprenticeship. In the Black Forest they found that the schools had extended their tuition to other matters besides watchmaking; they had begun to train their students in the manufacture of delicate electrical instruments. And in this country, if we were to keep ahead in the matter of electrical engineering, we should require very skilled handicraftsmen, who could construct the requisite delicate apparatus to develop the electrical discoveries that are being made. He had visited the Polytechnic School of Horology—the only one he could find in London—and he found it in a very feeble condition; he did not know whether it was still in existence. He believed there was also a class that was supported by the Watchmakers and Clockmakers' Association, but he had not come across it. In conclusion, he wished to point out that, if we were to prevent the loss that we were now sustaining through the decay of the watch-making trade which formerly flourished in our country, we must in some form or other endeavour to supply that technical instruction which these competing countries were giving to their students, and which was absolutely indispensable to enable us to regain the position we had lost. They had at Prescot a very large watch factory established on the American principle. That factory was growing aud employing, he believed, as many as a thousand hands, and was very successful notwithstanding the competition from abroad. But how much better it would be if all the people employed in that factory had had the benefit of a thorough technical education.

Dr. **Walmsley** (principal, Northampton Institute said that apprenticeship schools, as carried on on the Continent, were quite familiar to educationalists in London; but some of them considered that an apprenticeship school was not quite the solution of the difficulty, and that for many reasons. There were commercial reasons. Apprenticeship schools would tnrn out finished watches and so enter into competition with the trade, because a school which was endowed and equipped with skilled instructors, where waste of material was not of very great consequence, could produce watches under conditions which were no trade conditions. Though there is to be a Horological Department, it is not intended to set up an apprenticeship school in the new Northampton Institute for this particular industry, for they considered as a general rule that the manipulative skill in an industry could only be acquired by long practice in the factory, and the time that would be spent in acquiring that skill in a school could be far better spent in other ways—in teaching the art and principle of the craft rather than acquiring mere deftness o hand. He might add that the question of the connection of the electrical instrument making with watch-making had been perceived by them, and ther was on foot a scheme for combining the two. The were opening their first year classes in clock-making to electrical instrument makers, philosophical instrument makers, cycle gearing makers, and all trades in which small gearing played a part; and they hoped that they would thus meet a very definite want.

Dr. **Garnett** said he should like to ask Mr. Snape whether the organisation of the great and successfu industry in Prescot was of such a character as to give opportunity for technical schools to be useful in th training of the workmen there employed, or whether the work was so much subdivided that only th springers and timers required technical instructio in the laboratory or in the watch-makers' technica school. Those were questions which lay at the roo of technical instruction for the watch-making trade The governing bodies of Polytechnics and othe technical schools wanted to know whether they could hope to benefit the watch-making trade as carried on in the factory, or whether they could only hope to benefit the man who made his watch from beginning to end with his own hands. There was a serious difficulty in this country in the way of the establishment of apprenticeship schools on account of the question of what to do with the output of those schools, for unfortunately a school which was organised in the fashion of a workshop could not be carried on without making up something, and the material in some trades became a very important item in the cost of running the institutions. When the plumbers' classes were started in the North of England, a meeting was held at which there were present representatives of the employers, of the foremen, and of the operative plumbers, and ways and means were part of the subject discussed at that meeting. It was arranged to open classes, and to establish a plumbers' workshop, and promises were made, chiefly by employers in the room, of the whole cost of the equipment of the workshop. When the question of the material came up, it was stated that there were present persons who would purchase for their ordinary trade the work done in the workshop, and that the work so purchased would cover the cost of the depreciation in the metal spoiled. That looked very pretty, and no complaint was made; but within a few days it was announced that no articles made in the shops would be allowed to be used in the trade at all, but that everything that was made was to be kept for museum purposes, or hammered up, on the ground that no wages were paid for the work. Such action was, perhaps, quite justifiable. In the matter of lead work, it involved a comparatively small cost, but in other trades, the cabinet making trade, for example, this question was one of much greater importance, and it was necessary now in London to face the question, whether in the cabinet making trade they should compel the students in the technical schools to make chairs and tables and wardrobes and bookcases of one-half or one-third their usual size, and so make pretty models which were too big for dolls' houses, but too small for use, or whether, as he suggested, they should try some system of adopting a bonded store, as in the case of excisable articles, and undertake not to put to practical use the finished work until a sum had been paid upon it, equivalent to the ordinary wages as determined by a trade committee, and that sum so paid should be handed over to some friendly society in connection with the trade, in order that it might be used for the benefit of the trade which had produced the articles. It seemed to him that in dealing with the precious metals such difficulties, unless solved, would be fatal in the way of establishing apprenticeship schools in this country.

Mr. **Snape** said at Prescot the workers were kept to their own particular branch of the industry. The same thing applied in the cotton weaving, and cotton spinning classes in Lancashire. The factories kept one man at the mill, or they had another at the carding-machines, but that did not prevent them recognising the great importance of establishing cotton-weaving and cotton-spinning classes, and trying to get as highly trained a population to carry on this industry as possible. Those classes were found to be extremely useful. They could not expect that they would be attended by everybody employed in the industry, but the best part of the workmen attended the classes, and they were the part from which they got their foremen and managers.

Mr. **Steward** said that last week he had visited several large factories in Coventry, and there, side by side with workpeople making watches by machinery, he found men making the different parts by hand, and, in other cases, saw men making every possible piece of the watch by hand. The machine barely touched it.

TECHNICAL EDUCATION IN RELATION TO GLASS MANUFACTURE.

By Harry J. Powell.

Glass manufacture comprises many distinct branches, differing in organisation as well as in technique. Some branches involve large establishments, minute subdivision of labour, and the employment of large numbers of workpeople, whilst others may be regarded almost as "home" industries.

In the manufacture of plate-glass, of sheet-glass, of bottles, and of "pressed" glass, the labour is to a great extent mechanical, and the necessary training can only be acquired in the works. The workman's efficiency will not be increased by a knowledge of the chemistry of glass making, and although manual dexterity is essential there is no scope for artistic craftsmanship. The managers, however, should have been trained as chemists and engineers, and in works in which optical glass is made, they should also be physicists and mathematicians. The knowledge required by the manager of large glass works cannot be gained by attendance at courses of evening lectures. The most efficient aid technical education can render to manufactures dependent on applied science is to create a supply of competent managers by selecting capable lads from the secondary schools and maintaining them for three or four years at science colleges of university standing.

The manufacture of table and decorative blown-glass is generally carried on in comparatively small establishments. The smallness of the manufactories is advantageous from an artistic point of view, inasmuch as the wares produced possess a certain individuality, but disadvantageous from the fact that it is seldom considered economical to employ scientifically trained managers, and consequently the manufacture is carried on by the light of applied tradition rather than by the light of applied science. The smaller glass works, therefore, might benefit by the creation of a central institution, such as would be required for the training of managers for the larger works, to which the problems, which are constantly presenting themselves in all glass works, might be referred for solution.

The managers of works in which decorative ware is produced, are, or should be, master craftsmen. They require artistic training, but must be thoroughly conversant with the technique of glass making, and are able to learn more of glass design in the works than in a school.

The late WIlliam Morris, writing on the subject of technical education, said that to attempt to train a craftsman in a school is like trying to teach a boy to swim without water. Young glass blowers certainly cannot be trained in school, although schools might render them valuable assistance. The glass blower requires delicacy of touch, the power to appreciate form, and accuracy of eye. These qualities are helpful in all trades, and might well be inculcated in elementary schools. Boys, very properly, are forbidden by law to commence work in a glass factory till they are fourteen. If, when they are fourteen, their eyes and fingers, through want of proper training, are practically useless, they have little chance of becoming competent workmen. Young glass blowers would derive benefit from attending drawing classes, but unless these classes are provided in the works there is very great difficulty in persuading them to attend. Glass blowing is carried on in six-hour shifts, day and night, from Monday morning till Thursday night or Friday morning, and lads are naturally unwilling to give up any part of their Fridays and Saturdays to classes.

The requisite training in the glass house is long, and the prospect of success is small, it is, therefore, not surprising that, whilst skilled glass blowers, in spite of high wages, are becoming scarce, it is more and more difficult to persuade capable boys to enter the trade.

Some adequate inducement is needed to persuade boys to undergo the necessary training, as well as to give up some part of their leisure time to drawing.

The subsidiary trades of glass cutting, glass engraving, and tube working, are carried on in the larger works, as well as, to a certain extent, as home industries. They require considerable manipulative skill and long practice. The necessary apparatus is not costly, and the principles of the trades might be taught in technical schools. The demand, however, for cut and engraved glass is very limited.

It occasionally happens that a glass blower, trained in a glass factory, having saved money, starts as a manufacturer on a small scale, with a miniature or "crib" furnace in his back yard. He buys broken glass, melts it in small crucibles, and with the help of members of his family, makes lamp chimneys, bird fountains, small bottles, and other inexpensive goods. If such men could be persuaded to seek instruction in the principles of glass making they would be able to produce goods of better quality and greater value.

The artist in stained glass and the mosaicist can doubtless derive substantial aid from the art school, as study from the life can be better carried on in the school than in the workshop, but both glass painters and mosaicists must learn the technique of their crafts in the workshop.

It must always be remembered that the demand, whether for scientific or artistic education in connection with glass manufacture, can never be large. A single section in a single institution could supply sufficient scientific managers for all the glass works in the British empire; and a single art class in each town or district in which glass painters or mosaicists are employed would fully meet the demand.

An inquiry, as full as the time has allowed, leads to the conclusion that, whatever may be the case with other British industries, the aid derivable by glass manufacture from technical education must be very limited in extent.

NOTE.—The following are extracts from letters received relating to the value of Technical Education to the glass industry.

"We have not received any aid in the shape of Technical Education for our section of the glass trade from any source.

"BAGLEY & Co., Yorkshire."

"In this country Government grants are limited to the artisan class, whereas in Germany the Technical Schools are chiefly used by a higher class with the result of turning out a supply of trained managers, for whom a thorough knowledge of chemistry, physics, drawing, and, indirectly, engineering, is of course of the highest value. We have no evidence that a glass maker (*i.e.*, worker) is improved by Technical Education, and a revival of the old system of apprenticeship would be of far greater value and importance. The difficulty now is to get lads to thoroughly master their trade, which can only be learnt in the workshop."

"CHANCE BROTHERS & CO.,
"Birmingham."

"There has, quite recently, been an attempt to form a class from youths employed in glass-houses to study form, &c., at the School of Art, but I very much question whether any practical good is likely to result to the trade. My experience is that it should rest with the employer to supply designs, and be prepared to go into the glass-house and actually explain to the makers how his ideas are to be carried out, but then the difficulty comes in as to how far the society will allow its members to be free agents in the hands of the employers.

"L. J. MURRAY,
"Hon. Secretary of Midland Association
"of Flint-Glass Manufacturers."

"We have had no experience of technical education, but I may say that some of our best workmen have been instructed in drawing, and there is no doubt that a technical training would raise the standard of workmanship, and elevate the moral and social character of our members.

"J. J. RUDGE,
"Central Secretary of the National Flint Glass
"Makers' Society."

"So far as our own business is concerned, there can be no better school for those who desire to enter the glass trade than the glass-house, cutting, engraving, and etching shops, and the various other departments in the manufactory itself.

"THOMAS WEBB & SONS, Stourbridge."

Mr. BOUTALL said he should like to add to what Mr. Powell had said with regard to the danger of indiscriminate art teaching. There were a number of people who had had a certain preliminary training as draughtsmen, and were imbued with the notion that they were artists. For every genuine specimen of artist who had been produced by that kind of training, there had been at least 99 who were rank failures. There was this further danger, that while these persons were devoting their attention to a general art training they were probably neglecting some important application which would be useful to them in the work of everyday life. The study of the theoretical principles which underlie any industry should go on side by side with the practical training. Technical education should not supplant but should supplement the workshop training. With regard to the failure of the apprenticeship system, it seemed to him that probably the wisest course to pursue in regard to a general system of technical education would be to endeavour to resuscitate apprenticeship in some shape or form, and to combine the work of the technical school with it.

Mr. POWELL said one great difficulty with regard to trades which required manual skill was that of attracting boys into them. They had great difficulty in learning the trades, and both the boys and their parents feared they would never be successful, the boys, therefore, became errand-boys and clerks, instead of entering a factory where, if they took pains, they could earn high wages and become useful members of society. What he suggested was that Technical Education Boards should found scholarships for boys which should be dependent partly on regular work in factories, and partly on attendance in classes, so that theoretical and artistic work should run hand in hand with work in the factory. If some such plan could be devised, it would encourage young lads to take up skilled trades, and at the same time it would encourage them to be regular and attentive in their work. The London Technical Education Board had made some steps in this direction, but their scholarships were entirely dependent on attendance atclasses; something more was wanted — something that would encourage these lads to attend regularly, and give the whole of their faculties and interest to work in the workshop as well as to work in the classes. Some such plan would be exceedingly beneficial in all trades where manual dexterity was absolutely essential.

TECHNICAL EDUCATION IN ARCHITECTURE AND THE BUILDING TRADES.

BY W. R. LETHABY.

DEFINITION OF ARCHITECTURE.

In giving this title to the short paper which follows, I do so to explain its scope in current phrase. For myself, however, I must explain that I acknowledge no distinction between architecture and building. Architecture is the resultant of the association of the several building trades—it is the centre of gravity, as it were, of the crafts in combination.

While it is generally admitted that there is now no common speech and tradition in building matters, no current style of architecture, there has been much attempt to extol this architecture as something quite superior to mere common building. Fergusson, for instance, in trying to make out such a distinction says, in effect, that building is mere heaping of material together, while architecture is building done with thought and arrangement. He thus gives the title of building to a wholly supposititious product which has never had any concrete existence, so that he may give the title of architecture to building as we know it historically.

It suffices to say that the building product of antiquity is never so treated; the history of the architecture of Greece is what we know of the buildings of Greece—religious, military, domestic; the architecture of the middle ages is the masonry and carpentry, the smithing, plumbing, and so on, brought together in the wonderful works of that age. It follows, therefore, that the endeavour of the historians of art is to get at the typical and spontaneous in the art of the past so to re-construct the ages by all the monuments they have left behind. Modern English architecture is truly the whole product of the current customs of building in England. The architecture of London is the mass of building from Bow to Putney and from Hoxton to New Cross; and it is in the multitude of ordinary and characteristic buildings rather than in the few and exceptional ones that what is typical of this architecture will be found. The question of education in architecture is therefore not a question of nice scholarship which might affect the more costly buildings, half-a-dozen restaurants, clubs and insurance offices; it is the question of influencing the building of mean streets and the ordinary dwellings and meeting places of men. It is not merely an academical question but one of enormous practical importance to humanity and civilisation.

THE MEANING OF STYLE.

An explanation of the more apparent causes which led to the admitted break-down of tradition in architecture—that is building—in these modern days is part of a long story. Before glancing at it, it will be well to gain a clear idea of what this thing "style" has been in the past when art was, as we say, living. At such periods, architecture, as we can now see, was a natural development, the outcome of the experimental building carried forward by masons and carpenters. We see the needs and aspirations of society, the materials used by the builders, and all the other conditions of climate, circumstance, and thought so directly influencing their manner of building that it became a common and organic growth. This organic principle of building, the *style*, was a remarkable essence, a principle of growth born of the contact of mind, senses, and emotions with outer conditions; this style was not an accident, not a thing to be willed or altered, it was in the nature of things spontaneous, communal, national, racial. A building was a natural product another kind of tree, as it were, growing on the earth's surface, answering to every condition of soil and climate, and responding to every breeze of thought.

Literature is but the written word, architecture is the builded word; the writer and the builder are alike nothing except so far as they crystallise some of the thought stuff behind phenomena—the ideas waiting to be born. And, further, a true style can only answer to one moment in the world's history; we may speak of Hellenic, or Byzantine, and of the 13th and 14th century styles, but really style changed from day-to-day. Any mere invention, if it were possible, of new shapes, any intentional originality, would be as trivial as our copying of the styles of the past. Of course, I must be understood to speak of expressional forms, not of useful inventions.

Our modern relation to facts on the side of architectural thought is, of course, exactly represented by our current building speech. We are revealed to ourselves in the corrugated iron shed, the mean meeting-house, the restored cathedral, the sham Gothic church, the sham Renaissance town-hall, the dull workhouse, silly villa, and the general vulgarity of the streets.

All this is ourselves built large, and yet I hope that we are not so bad as we look, for we are the victims of our historic position, and if we find ourselves in a *cul-de-sac* we didn't put ourselves there. Still it is a melancholy reflection that all this time there would have been a true style of building proper to this moment alone in the world's history, if we could only have been in connection with the great governing principles of practical building, a vital stream, instead of being choked by the scum of an outspent eddy of scholasticism.

I am going to become more practical instantly, but what becomes of the architecture never built—the architecture of 1897?

OUR HISTORIC POSITION.

At the beginning of the sixteenth century a vast revolution occurred all over Western Europe. The Church broke in two, traditional customs were largely replaced by statutes imitated from Roman law, the free towns were overawed, and the national folk architecture withered up before a fashion for imitating Roman building seized on with avidity by all the Courts in Europe. Reformation, Revolution, Renaissance, were but complementary phases in the fields of religion, politics and art of one great movement, by which the guilds were dissolved, the ideal of the towns uprooted, and the craftsmen who governed them taught their place. The guilds of the workmen had been inextricably bound up with religious brotherhoods and with the corporations of the towns (the municipalities or communes were, indeed, based on the guilds) so all were struck at together.

The revival of learning, as it is called, worked in perfectly with the great wave of reaction and absolutism. Roman law was ransacked for pretexts, and a scholarship of Roman art became a lever to thrust out of the way the customs of the crafts as held by the guilds. At this time a set of drawing-master designers, commercial travellers in art, came from Italy, and hung about the Courts of France, Germany, and England, and displaced the old master masons and carpenters who held the living traditions of building art. These Italian designers were for the most part painters rather than masons, and from this time the architect became a painter or drawing-master of buildings rather than a graduate of the shops.

As the old architecture of the people was to be broken down, arguments were easy to find. One of the most potent and convincing of these arguments is that which is set out by one of the earliest and ablest of the drawing-master designers of France, Philibert de l'Orme, thus:—Roman architecture was antique; Solomon's temple was built in antiquity, therefore Solomon's temple was built according to Roman architecture; but the plans for Solomon's temple were drawn in heaven, therefore Roman architecture was divine and revealed, and the ways of building followed by the mediæval masons were of the nature of heresy. It was necessary, according to De l'Orme, to return to the "vray" architecture in its purity.

Building from this time ceased to be experimental workmanship, tradition behind and reason in front; it became an essay in "vray" architecture; and scholars in classical antiquities passed themselves off as "architects," which they could the more easily do as the old experts in building were employed to do the work while the scholars provided the pretty patterns, not according to the customs of the craft any longer, but such as might tickle the fancies of Italianised employers.

But it is easy to see that this theory could not last. Scholarship feeding on a limited field soon exhausted itself. Nothing remained to the scholarship theory of architecture when this exhaustion had become apparent, but flatly to reverse the argument, and this Pugin did. Pugin arose with beautiful enthusiasm to prophesy that the old despised way of building practised in the middle ages which had come to be called "Gothic" or barbarous was the true Christian style after all. Then the scholarship engine was set going once more full speed astern.

This cry, in turn, exhausted itself in some sixty or seventy years; we can see, indeed, that this was in the nature of necessity. This second school of copyists were not nearly so unanimous as the former, nor were the students so self-convinced, yet it is to be noticed that both these revivals (so-called!) were entered on with a certain belief and fervour—the revival of antique, true, or revealed architecture, and the revival of true, Christian, or pointed architecture. The first entirely succeeded in suppressing "Gothic" architecture; the second only half succeeded in establishing sham Gothic architecture.

So much for the immediate past; what of to-day? These two enthusiasms having been worked through, scholarship is not equal to another act of faith and has fallen into architectural scepticism. We don't believe in any architecture being "vray" now. So far as scholarship of design goes there is now no attempt to work in concert except by the professors of church restoration, who follow Essex and Wyatt in rebuilding the cathedrals to taste and with dispatch. This tail of the Gothic revival, cannot however last for more than a few years. When all the real Gothic has been altered into sham Gothic, that enthusiasm also will have evaporated.

All theories of what has been called "architectural design" have entirely broken down under examination, and it has become apparent that the truer the style is, the closer is its relation to its time and environment. It has become apparent that there is no absolute architecture, but that true style and rational building can only be the outcome of the conditions of the moment in the wise satisfaction of true needs, and by the interaction of handiwork and the materials with which it deals.

While we have been finding out this, it has become as clearly evident that any lingering remnants of the old system of workmanship preserved traditionally by the workmen are disappearing. Just as we have realised that the very basis and main substance of architecture are beautifully built walls of carefully selected materials, timber framed in a workmanlike way, deftly laid plaster, columns proportioned to material, windows and doors shaped for service, and so on, and not certain patterns arbitrarily selected by a professor of design, it has become evident to us that the body of workers' skill which the earlier masters of "design" like Wren had to deal with has been continuously decaying and disappearing since the destruction of the guilds. For be it remembered that some of the methods of the guilds survived for long their official destruction. At the beginning of this century the theory of the crafts being based on due apprenticeship was still maintained. And in country towns some who called themselves masons *and* architects were still to be found.

We designers on the one side have lost faith in scholarship in design; on the other hand the workers are untaught and therefore unintelligent and uninitiative.

THE GUILDS.

To look back again to the middle ages. The masons and carpenters' guilds were faculties or colleges of education in those arts, and every town was, so to say, a craft university. The folk of the middle ages were not so ignorant as to look on dead languages, history, and statistics as the only forms of learning. Masonry, carpentry, smithing, plumbing, were media for the exercise of intelligence and aspiration. It has been well pointed out by a recent historian of the Universities, that they are but surviving examples of the associations of the middle ages—Scholars' guilds.

Corporations of masons, carpenters, and the like, were established in the towns for the ruling of production and the teaching of the craft. Each craft aspired to have a college hall; and a city like London was full, first of the buildings of the religious brotherhoods—the churches; then of the halls of corporations or lay brotherhoods. Guildhall was, as it were, the secular cathedral on which the smaller company halls depended, like parish churches, of trade and craft. We are usually told that "feudalism" was the social principle of the middle ages, as if there had been a "social contract." The truth is, society in the middle ages formed itself into groups, mainly in accordance with the callings of its members. The association or group, not the individual, was really the unit of society and basis of competition.

The guild, which regulated all the customs of the trade, guaranteed the relations of the apprentice and the master craftsman with whom he was placed—master, be it noticed, not in the sense of employer, but in the sense of graduate of his craft college and wearing its robes. The boy was really apprenticed to the craft as a whole and ultimately to the city, whose freedom he engaged to take up. The boy apprenticed to a mason mixed mortar, tidied the shop, and generally learnt his craft by assisting an expert during a seven years' course. Each master might only take one or two apprentices at a time, for they learnt by working with him. At a certain stage the apprentice became a companion or bachelor of his art, and later by producing a master-work, the thesis of his craft, he was admitted a master—one of the governing body of his college; and only thus was he permitted to become an employer of labour. Then as a citizen the dignities of the city were open to him and the great things of his art. He might become the master in building some abbey or cathedral, or as king's mason, one of the royal household, and the acknowledged great artist of his time in what was then called Mason-craft. The buildings of the middle ages are indeed wonderful, but is it so wonderful after all that they were produced when the building trades were so organised? Our ideals and system are as perfectly reflected in our modern architecture of London where a vast mass of common building, which I will not attempt to describe, is diversified here and there by a careful design done out of an architect's head after study of the real mason's art of the past, and built by farming out to a financial agent called a contractor, by gangs of men who have no say in the matter, and who for the most part have "picked up" their trade.

Some argument has been spent on the question as to whether the modern trade unions represent the ancient guilds. The question in one respect is as nice a one as that of apostolic succession in the English church. In a broad sense, however, there is not the least doubt that guilds and unions are alike forms of those associations of the workers which are known to have existed far back in Greece, were highly systematised through the Roman and Byzantine eras, won their highest positions with the assumption of the government of the free towns by the merchants and craftsmen in the middle ages; and crushed and disinherited in England under Henry VIII. reappeared in the various forms of benefit clubs, wages unions, and the trivialities of freemasonry. What we call by the meaningless term Gothic architecture was the ordinary current work sanctioned by the guild. From such considerations I have reached the conclusion, that the building system of any time and country has always represented the state and activities of the guilds or unions. Now, as the organisation of scholarship is the affair of scholars, and medicine the business of doctors, only masons and carpenters can organise and develop the arts of masonry and carpentery. If ever a living style of architecture can again be made economically possible it is by the unions of the several crafts assuming guild functions, seeing to the education of its learners, setting a standard of quality in production—in a word, assuming the entire responsibility for the whole conduct of their crafts—and nothing effectual can be done without them. If the unions, stirring themselves in this way, can vitalise the building crafts, we shall get a building art once more, otherwise we shan't. The real question before the unions is not one of a halfpenny an hour more or less in wages, but the architecture of their country. They are far from realising this responsibility—we are far from having a reasonable and living style of building.

OF SCHOOLS.

The members of unions or guilds must themselve consider the matter of education. This work done for them from without would be of comparatively little good. The education itself would be of less value than the interest and goodwill which would vitalise any craft which took up its own education. Moreover, there is likely to be large waste in any system of specialised craft education organised from without. Such a system often eats up the substance; by an artificial preoccupation with the fringes of a subject; and in too carefully considering all the avenues of approach the thing itself at the centre may never be reached. Professional education generally is prone to run to grammar as in the English system of teaching languages. Literary organisers of education have a great dislike to empirical methods, but art itself is empirical, and our literary friends must not deceive themselves by their own phrases. If, as we are told, we are to be governed by experts, the things of art and craft must be organised by expert artists and craftsmen. Indeed, the modern literary view of education—that the chief end of man is to count statistics and read newspapers—must be broken with in approaching this question of craft education, for I believe we shall not get very far till we recognise that a literary education is only one of a dozen avenues leading to true but dissimilar culture. Craft excellence must once more be made an object of ambition, through which the craftsman as such may reach to some of the world's rewards, such as they are. The only reward obtainable in a craft must not be the getting out of it.

It should be a warning to craftsmen that the downfall of the crafts, brought about by the conspiracy of the Renaissance, has been confirmed in the name of science by the gentlemen who undertaking research into the laws of production and distribution, considered only quantity and never once thought about the quality of products. May I say here, in brackets, that the position the State, the public, democracy, or whatever we like to call it, occupies as employer of labour is a very important question indeed. At present public works tend to a base mechanism varnished over with what is thought to be ornamentation. What is the good of endeavouring to teach art if we would have none of it if it were produced?

But to return. School learning, however practical, can only form a small portion of the true education of the true craftsman. The organised crafts must further find a way by which the essentials of apprenticeship shall still be obtainable in the shops and on the works. The essential of apprenticeship is the association of a learner and craftmaster in real production, under the sanction of the guild; this also must ultimately be the affair of the unions. If we are to make architecture an experimental art once more the foundation of the whole structure will have to be a number of schools in the several building crafts. In a school of masonry for instance there would be a museum of stones and a collection of tools. Strains and crushing weights would be investigated experimentally, and the equilibrium of arches and vaults studied. Problems of setting-out and practice in actual cutting should go hand in hand. Methods now gone out of use such as axing would be tried over again. Such a school in the hands of expert masons willing to consider methods new and old on their merits, would, I think, soon alter our current procedure. In a few years I should expect to see the present method of rasping the external face of masonry all over with a drag and leaving it to the weather with the pores well laid open, given up in favour of the traditional plan of finishing the face with a sharp cutting axe and coating it at once with whitewash, which in old times was used as a thin preservative coat of plaster. I should expect the trade taking cognisance of these tests of material and research as to methods to make known the results, so that a body of sound rules in masonry might be made available. At present masons whisper that certain large London works specified to be built of Portland stone are really often executed in Ancaster, or even Bath stone. The old guilds appointed "viewers," "searchers," or "wardens" to keep their eyes on this sort of thing, which they would not allow for the honour and true welfare of masonry. All this is the affair of the craft, and we must charge on the union the responsibility of seeing to it.

I suppose similar schools to exist for carpentry, plastering, plumbing, all of them nearly lost arts in any high sense; design in evrey case being approached as an outcome of positive conditions, not as an arbitrary pattern devised by hashing up the forms truly evolved in the past by experimental workers.

Architecture, is I have said, the combination of these crafts to special ends. The architect of the past (best represented by the building foreman of the present) was a mason or carpenter, and I am convinced that ultimately the great crafts should largely reabsorb the architect. In the mean time, however, although the path must be opened out by which the able practical mason and carpenter may become directors of building, it is necessary to educate a class who are specially brought up to direct crafts they do not practise, so that they may direct them as little capriciously as may be. The youth intended for an architect should in every case pass through the elementary stages of the masonry and carpentery schools along with the masons and carpenters, and he should have the run of all the other craft schools under certain conditions. He should moreover in a special school of Building consider the crafts in combination and the conditions and traditions of the several types of arrangement suitable for different classes of buildings. As a return of courtesy and service this school of architecture should be open to the craftsmen who wished to know something of building as a whole. The architect's special work is to be an expert in arranging and combining. The quality and details of the masonry are necessarily mason's matters; the curls and twists of the ironwork are the blacksmith's business; plumbing, sanitary and ornamental, is plumber's work; it is a ruinous policy, which instead of throwing on the workers the responsibility in their several trades, stirs up their instinct to get the better of clerks of works and architects. The architect's essential function is not to guarantee the quality of materials and workmanship he does not fully understand; it is not to design ornament out of his head so that materials which he has never wrought with his hands may be tortured into a semblance of his intention by mechanical workmen; his true function is to arrange and contrive highly specialised buildings, to act as an intelligence department for the several crafts, and as one having a knowledge of building as a whole to advise his employers.

At the present time building should be plain, straightforward, sound, and, as far as may be, reasonable; mere plainness and even baldness do not insult us like heartless bedizenment, or the assumption of the trappings of antiquity.

Mr. Powell said the writer suggested that the unions were to take up the work of teaching building and architecture, he should like to know how he proposed to vitalise the unions, and get them to take up this work. So far as he knew, they were not eager to move in that direction at the present time.

Mr. Lethaby, in reply, said that was a large question, and approached the subject from above; his paper might be taken as intended to stir up the unions from beneath. It was not for him to show how everything would work. He thought the unions should get hold of funds and help wherever they could, but the types of craft education would have to be settled by the several crafts themselves.

The Chairman said it seemed to him that architecture was an art, and although you could train man to a mechanical business, you could not make man an artist by any amount of instruction.

THURSDAY MORNING, JUNE 17, 1897.

Section A.

William Bousfield, M.A., in the chair.

The Chairman, in opening the proceedings, sai that he believed Mr. Mundella, in his speech yester day, impressed upon the Conference the desirabilit of dealing as far as possibly with the higher side technical education. Of course, polytechnics dealt wit rather a wider sphere, and embraced both the highe and lower sides of education; they were especially London and an English product. He presumed th present discussion would more especially interes English people, inasmuch as our technical educatio was in the progress of growth, and that growth ha proceeded in a peculiarly English manner. The poly technics in London had to a large extent taken their lines from the work of Mr. Quintin Hogg, in his formation and development of the Regent-street Polytechnic. He did not think that in any discussion in which polytechnics were mentioned they could omit to mention the very great debt of gratitude that was owed to him for the self-denying energy that he had thrown into the organisation of this polytechnic. As everyone knew he had been prodigal, not only of his time and energy, but also of his money in the good cause, and he could look back upon this fact, that in taking this trouble and spending this money he had succeeded in setting an example which had been very largely followed in other polytechnics. The London polytechnics would have been impossible if it had not been for the use of the endowed funds coming from the City parochial charities, the direction of which had been shadowed out in the report of the Charity Commissioners, uuder Mr. Anstie. No doubt, a very large number of experiments had been made in the polytechnics throughout London; some of them had had permanent results, some had not. He did not think they ought to consider any of those experiments had been wasted. Even where the experiments had not led the way to a permanent line of teaching, they had always shown the difficulties which had to be met and the way in which other branches of teaching could be best developed. The other funds from which the London polytechnics had largely derived their resources came through an accident—the accident of the money coming from the wine and spirit duties being suddenly given to the various County and Municipal Councils. That he must characterise as one of the most happy accidents that he had ever witnessed in Parliamentary proceedings. Local bodies throughout England had been able to aid technical education in a way which would have been quite impossible if they had not had these funds to dispose of.

POLYTECHNICS.

By Quintin Hogg.

In dealing with the Polytechnic movement in London I must first of all ask my hearers to disabuse their minds entirely of the meaning which the word "Polytechnic" bears on the Continent. There it is applied to the highest grade school, whereas, with us it is intended for the rank and file rather than for the *élite* of the scholars, and there are other radical and essential differences which will be dealt with as I proceed with this paper. The very term "Polytechnic," though singularly applicable, arose more from the accident of the old Royal Polytechnic coming into the market at the time when the writer needed larger premises than from any deliberate choice of the name itself.

It has been suggested to me that it would be a fitting commencement to this paper, were I to trace briefly the growth of the Institute which created this generic name of "Polytechnic," and the history of which is more or less the history of a development on the lines of the least resistance, as suggested by practical experience.

The seedling first saw the light just after Christmas, 1863, when the writer took two crossing-sweepers into the Adelphi arches, which were then open to the river, and with a beer-bottle and a tallow candle for the entire lighting apparatus, a couple of Bibles wherewith to teach the letters of the alphabet as the entire school furniture, the two crossing-sweepers as the total of the scholars, and himself as the teaching staff, commenced a very elementary ragged school. This grew until it needed a home of its own, which was secured in "Of-alley," off the Strand, a court forming part of the estate of the great Duke of Bukingham, and marking the site of his river house, the streets George-court, Villiers-street, Duke-street, Of-alley, and Buckingham-street, giving the name of the nobleman in question.

A day school for small boys under a female teacher, a City Missionary working the district in the immediate neighbourhood, an evening school for elder boys with its comcomitants of penny bank, lending library, shoe-black brigade, &c., were the agencies carried on in this small room with a rental of £12 a year. Soon another room was added, then the adjoining house was taken at a rental of £26 a year, wherein those boys who had no homes, or worse than none, could sleep for 2d. per night. But the success of a ragged school rings the knell of the ragged character, and for a school to keep entirely ragged in the full sense of the word, should probably be started afresh every two or three years. At the school in question, the boys gradually passed into the Shoeblack Society, and obtaining sufficient money to buy decent clothes, soon began to raise the standard of the school. Instead of ragged and almost naked boys (five of them used to come with nothing on but their mother's shawl pinned round them) cleaner and better class lads began to attend. The boys who did well in the Shoeblack Society were apprenticed, and brought their companions, young mechanics from small workshops, to the school, and after six years a move was decided upon to the neighbourhood of Drury-lane. Here the same influences were at work, and in 1871 a small Institute was formed, the members of which conducted the Ragged School, and had set apart for themselves a small house adjoining. Here, for the first time, science and art classes were commenced. The numbers grew until a boy had to wait over a year in order to get into the Institute, which was, to a large extent, self-governed, and in 1876, a fresh move became necessary, this time into Long-acre.

The Ragged School and Boys' Home were left behind in their old premises, and the entire space at Long-acre was devoted to the Institute. The limit of 500 members was soon reached, and once more a difficulty arose from the numbers desiring to join and the very few desiring to leave.

It was in Long-acre that the present director of education, Mr. Robert Mitchell, who had previously been elected by his fellow members to fill the post of honorary secretary, took up the post of secretary to the Institute, and became the important factor he still remains in the development and conduct of all the variations of our polytechnic life.

By this time certain salient facts stood out clearly in the minds of those who had been working with the boys. The first was that, given a suitable place and suitable management, there was no difficulty at all in attracting London boys to an educational and social Institute; the second, that so far as the writer could see, no existing institute had recognised the fact that God had given a young man more than one side to his character. There were educational academies, of which the Birkbeck was, perhaps, the most notable, which were educational and nothing more; there were religious institutions, such as the Y.M.C.A.; there were athletic clubs and working-men's institutes, but each and all were either solely educational, solely religious, solely athletic, or solely social, and what appeared requisite to those who guided the fortunes of the Polytechnic was a place where a young man could develop any one of these "sides," and would find a reasonable outlet for any healthy desire, physical, spiritual, social, or intellectual, which he possessed.

Another plain fact stood out also as the result of their experience, namely, that if you want a place for young men, you must more or less limit it to them, and that on the one hand very young boys or children skylarking about the place and turning it into a romping ground, or on the other hand middle-aged and elderly men who would scowl at any hearty laugh or youthful amusement, would alike keep away young men.

From the first, therefore, a limit had been imposed requiring candidates for membership to be between the ages of 16 and 27, though when once admitted they might remain as long as they chose.

In order the more fully to carry out his ideas, the writer determined to build an Institute which should afford scope for a many-sided work, and, as he hoped and believed, would serve as a model for other institutes in London. A large plot of freehold land lying between Holborn and Drury-lane had already been purchased when the old Polytechnic came into the market. The site was one that would be sure to challenge attention, more so than one hidden away to the east of Drury-lane, and after consultation with his colleagues, it was purchased and fitted out for the accommodation of an assumed membership of 2,000. During the nine months required for alterations and partial rebuilding, the numbers at Long acre were allowed to go up to 1,000, and with that membership the great hall was opened on Sunday, September 25th, 1882, being crowded with 1,500 young men who met to celebrate the opening of the Polytechnic and to ask God's blessing upon it.

Up to that time it had been the writer's custom to see every boy individually as he joined, and in pursuance of this custom he started interviewing new members at five o'clock on Monday, the 26th September. The numbers entering were prodigious. He was unable to leave his desk, even to get a cup of tea, until a quarter to one the following morning, and by that time a thousand new members had joined the institute.

In the meantime Mr. Mitchell had got out a very extensive class list, embodying, so far as could be, the experience of those who had gone before us. Trade classes, workshops, and technical classes of all kinds had been added to those which had been carried on at Long-acre, with the result that during our first session no less than 6,000 individual members and students made use of the Institute, and if, in dealing with the question of numbers, I may anticipate a little what should, perhaps, more properly belong to a later part of the paper, I may say that each succeeding year has shown a progressive increase, until at the present time no less than 16,000 members and students make use of the Institute each year. Nearly 5,000 use the Institute every day, of whom about twelve to fifteen hundred are day students, and the remainder evening students or members.

There are at the Polytechnic during the

winter over a hundred classes every evening, and by attending to the reasonable wishes of the Trades Unions, we have not only not met with any opposition on their part, but in nearly every case with their assistance and advice, the rule having been strictly adhered to that only young fellows engaged in the trade taught may attend the trade classes.

The motto of the Polytechnic has been to endeavour to provide some training for the head, the hand, and the heart, and certainly no Polytechnic adheres to the orignal idea which misses out any one of these from its program.

The key to the whole position is the social life. Young fellows attend the Polytechnic from all parts of London and suburbs, coming in some cases from such places as Eton and Oxford to attend either the day or the evening classes. At any moment it is easy to tell how the Institute is progressing by going into the social - room, and noticing if the members are in brotherly touch with each other or the reverse. If the former is the case you may assume at once that the educational, physical, and spiritual sides are alike progressing favourably, and it seems to the writer that it is largely on the social side that the new Polytechnics incur the greatest danger of shipwreck. Again and again the writer has been told that the social side will look after itself. So far from such being the case this same social side involves more trouble and personal labour than all the other portions of the Polytechnic work put together. Yet without this social side the Institute sinks into a mere academy, and ceases to be a Polytechnic altogether.

In dealing with large numbers such as congregate at the Polytechnic, it is almost necessary to deal, with them by sections, and here the athletic and social clubs give powerful assistance. For the use of the larger sections special club-rooms are set apart permanently. Thus there is a club room for the Polytechnic Athletic Club, which includes cricket, swimming, Rugby and Association football, lawn tennis, and rowing. There is another room for the cyclists, who number from two to three hundred, and who constitute the best racing club in England. Another is set apart for the harriers, who, like the cyclists, number men holding amateur world's records amongst their members. Another room is set apart for the old day-school boys, who are encouraged to join the institute.

There are in addition almost innumerable societies, to wit, the largest local parliament in England, ramblers' society, several minor cycling clubs, boxing clubs, gymnastic societies, mutual improvement societies, reading circles, temperance societies, and others.

The athletic club have a boat-house at Chiswick, and perhaps the finest cricket ground in England at Wimbledon, while a large swimming bath serves its original purpose during the summer, and acts as a most efficient reading-room in the winter.

Amongst other attractions, and I use the word advisedly, is a very definite amount of distinct religious work. This is wholly unsectarian in the fullest possible sense of the word, and I think those who fear any hostile feeling to this side of the work would only have to mix with our members to assure themselves of its absolute absence. On the other hand, it is difficult to over-estimate the value to any institute of the influence of those parents who care most for the well-being of their sons and daughters, and who throw the immense influence of a Christian home in favour of an institute where the spiritual side of a boy's nature is not ignored.

No rule exists for compulsory attendance at classes, but out of 16,000 attending the Polytechnic, no less than six-sevenths attend some form of educational work of their own accord.

Many a young fellow has told the writer that he joined the Institute solely to use it as a club, but was so struck with the atmosphere of work about the place that he almost involuntarily became affected by it himself.

Another very valuable form of social-educational work lies in the combination of certain classes. Thus the students in the engineering classes form themselves into an engineering society, as do those attending the French, shorthand, German, building, architectural and other classes. These educational societies, if I may so call them, involve no expense to their members, save that which is necessary for stationery and postage, but meet once or twice a week for the purpose of assisting each other in the prosecution of their common aims.

In 1887 a boys' day school was started, largely with the view of having a technical side, and it has long since reached its maximum of between five and six hundred students. Since then a girls' school of a little over 200, and an advanced engineering school of between 50 and 60 students, have been added.

Another very important class is the photographic, under an especially able master, who was the first to introduce into England the teaching of various processes which had hitherto been practised only on the Continent. Tailors' cutting, cariage building, and other classes of the kind are also held.

I have endeavoured in the above to give some slight sketch of the pioneer Polytechnic. It now remains for me to indicate how financial support has been provided for it, and for the others which have sprung up during the last few years.

Just about the time that the Institute was moving into the Polytechnic, the Royal Commission on Technical Education made its first report. Later on some of the members of this Commision visited the Polytechnic incognito, and were so struck by what they saw there, that they reported in the most favourable terms to Her Majesty's Government.

The London Trades' Council, on April 10th, 1883, passed the following resolution:—"That the system of trade teaching adopted at the Polytechnic Institute be recommended to the London trades." Three months later the same Council resolved that "In the opinion of this delegate meeting of trades, any system of technical, scientific, or theoretic instruction for our industrial population should be accompanied by practical teaching by competent trade teachers, based upon workshop practice, in harmony with the requirements of ordinary business pursuits, similar to the trade instruction given at the Polytechnic Institute." More recently Mr. Woodall, M.P., a member of the Royal Commission on Technical Education, said that "he had, in connection with the Royal Commission, visited nearly all the technical training schools on the Continent, and he could safely say that he had not seen one in which such a thorougly practical system was followed as in the Polytechnic Institute."

In the meantime another Royal Commission appointed to deal with the charities of the London City parishes, had resulted in the temporary addition to the Charity Commission of a new department, for the purpose of dealing with certain sums which had been left by benefactors, long deceased, for purposes which, from one cause or another, had really ceased to exist. An interesting paper might be written of itself on this subject. Lands, which at the death of the testator had brought in an income of £15 per annum, had in the intervening centuries, been built upon, and their income increased a thousand fold. Whole parishes had been absorbed by warehouses and banks, and the poor population had been replaced by a fairly well-to-do class of caretakers. Altogether the charities which had been scheduled by the Charity Commissions, possessed, in 1887, an income of £104,904 13s. 4d., of which £17,718 9s. 4d. had already been administered under the schemes of the High Court or the Charity Commissions, while schemes had been submitted, but not yet approved, for the administration of a further sum of £6,171 5s. 9d. This left £81,014 18s. 3d. to be dealt with, but the above did not include certain funds administered by the parochial authorities, but claimed by them to be the absolute property of the parish, and not the subjects of charitable trusts.

The Charity Commissioners found themselves saddled with the cleansing of an Augean stable. Some of the charities had no banking account, others had put down considerable sums under the somewhat comical title of "visiting the tombs," which upon examination was found to mean eating dinners at the expense of the charity. The entire parish of St. Christopher-le-Stock had been absorbed by the Bank of England, and another, St. Anne and St. Agnes, by the General Post Office, while St. Bartholomew-the-Less possessed one house only in addition to St. Bartholomew's Hospital. In many of the parishes all the parochial machinery was kept up. In others it was found that there were no poor, though the Parish of St. Vedast claimed to have one poor person. Some of the title deeds and declarations of trust had been lost in the fire of London, and with them the history of the original objects of the trust of the testator. Much of the money was used for paying the poor rates of the parish, and thus relieving freeholders and tenants from their legitimate burdens.

It so happened, therefore, that a sum of money which may be capitalised at over three millions, became available for public purposes about the time that the need for improved methods of popular technical education made itself felt in England, and that general attention had been attracted to the Polytechnic through the report of the Royal Commission above mentioned.

The temporary Commissioners upon whom devolved the duty of preparing fresh schemes for the administration and use of this money were Mr. (now Lord) Sandford, and Mr. James Anstie, Q.C., with two Assistant Commissioners, Mr. E. Bond (now M.P.), and Mr. Henry Cunynghame. Lord Sandford did not actually enter upon the work of a Special Commissioner, and it consequently fell to the lot of Mr. James Anstie, Q.C., with the Chief Commissioner, now Sir Henry Longley, K.C.B., to undertake the responsibility of drawing up the new schemes.

To the wise and sympathetic action of these gentlemen the educational and social centres which have recently grown up in various parts of London are largely due. Sir Henry Longley still continues to discharge the duties of Chief Commissioner, and his name is constantly before the governing bodies of the various Polytechnics and others interested in their welfare as that of a wise and experienced adviser, with the rare gift of combining strict official supervision with that of understanding the value of individual idiosyncrasies.

It was on Mr. Anstie, however, that the great labour and responsibility of the work chiefly fell, and it was with regret that his friends saw him, when he had given to London its great scheme of secondary technical education for the poorer classes, retire like Cincinnatus into private life, anxious, apparently, that the 50,000 students who are now availing themselves of the advantages brought within their reach should never know the name of one of their chief benefactors.

The work of the Commissioners consisted in obtaining full particulars of the several charities dealt with by the City Parochial Charities' Act, and in preparing schemes for the future administration of these funds. The principal scheme established the Central Governing Body of the City Parochial Foundation, to which was committed the administration of the funds, subject to the Commissioners' schemes, from the date of the cessation of the temporary powers of the Special Commissioners.

Into the schemes themselves we need not go too closely in this paper. They would require a pamphlet to themselves. Suffice it to say that London was to a great extent mapped out, and Polytechnics suggested for various parts, certain funds being offered conditionally upon local aid being found, and most of these bold dreams have become solid and beneficent facts. There now exist, in addition to the original Polytechnic in Regent-street, the following Institutes, most of them bearing the Polytechnic name, but all of them more or less running on the lines laid down by the Charity Commissioners as the result of their inspection of the Institute in Regent-street:—

The People's Palace (opened in 1887) endowed by the Charity Commissioners, but mainly supported by the Worshipful Company of Drapers.

The Goldsmiths' Institute at New Cross, opened in 1891, without funds of any kind save those supplied by the Worshipful Company of Goldsmiths.

The Woolwich Polytechnic, opened in 1890.

The South-West London (Chelsea) Polytechnic, opened September, 1894.

The Battersea Polytechnic, opened January, 1894.

The Northern Polytechnic, opened October, 1896.

The City Polytechnic, with which is incorporated the Northampton Institute (opened July, 1896), the City of London College (opened 1847) and the Birkbeck Institution.

The Borough Polytechnic (opened September, 1892) including branches at Norwood and Bermondsey.

Some of the above Institutes have been the subjects of munificent individual gifts. The Northampton Institute stands on ground given by the Marquis of Northampton and Earl Compton of the value of £30,000, while the South-West London Polytechnic stands on ground given by Lord Cadogan, of the estimated value of £10,000.

In the meantime a most valuable additional source of supervision and endowment had opened up from another quarter. In 1889 the Tcehnical Instruction Act was passed, which empowered local authorities to levy a rate of one penny in the pound for the purposes of technical and manual instruction. At first little advantage was taken of the powers conferred by this Act but in the year 1890, the then Chancellor of the Exchequer, the Rt. Hon. George J. Goschen, passed through Parliament a resolution making available for the purposes of the Technical Instruction Act, certain moneys specially raised from beer and spirits, which had been originally ear-marked for the purpose of compensating individual publicans who might lose their licenses in connection with a scheme for regulating the liquor traffic. The compensation scheme failed, and the money raised for carrying it into effect was at the disposal of the Government. This money was placed at the disposal of the various County Councils, with authority to use it for technical education, a hint being given by the Government that if so used the grant would be made permanent. In the year 1893 the writer moved a resolution, which was seconded by Mr. Sidney Webb, who has ever since so ably presided over the Technical Education Board of the London County Council, setting aside a portion of London's share of this money for technical education. The first act of the Technical Education Board, which was created by the London County Council for the purpose of administering the grant, was to get a report by Mr. Llewellyn Smith, who had had much experience in educational matters in the East-end and elsewhere as secretary of the National Association for the Promotion of Technical and Secondary Education, on the condition of technical education in London. The report was presented, and various recommendations made, which have been carried out with admirable success by the Board, who have been especially fortunate in their chairman, and also in obtaining the services of Dr. Garnett as their chief officer and adviser. The key-note has rightly been co-ordination. To borrow an illustration made use of by Mr. Sidney Webb when seconding the resolution which was passed by the County Council in 1893, there were numerous pipes, all of them good and serviceable, but belonging to no one combined system, and Mr. Webb laid down a line of action which he has consistently carried out ever since, of endeavouring to combine whatever good work was going on in London into one efficient whole.

It would be difficult to speak too highly of the manner in which all those who have had charge of this great work of technical education in London, whether belonging to the Charity Commissioners, the Central Governing Body of the City Parochial Charities which was formed by them, or the Technical Education Board, for the manner in which they have consistently nurtured and strengthened existing institutions, instead of killing them out by starting rival centres of education of their own. Everywhere this beneficent system has been adopted, with the result that London has made extraordinary progress during the past decade, a progress which the writer believes is merely a promise of still better things to come. The proper status of the Polytechnic in the great scheme of technical education is gradually taking shape. It is not, and should not aim, at being a place for the talented few. These can be best dealt with by special schools, such as that at South Kensington, and possibly one or two carried on by the Technical Education Board on a scale, and with an amount of personal attention, which could not be achieved, and should not be attempted in a Polytechnic. The Polytechnic should deal with the rank and file of our artisan classes. It should endeavour, if possible, to specialise certain classes useful to trades especially strong in the districts where they may be located; it should act as a centre for the Board Schools and smaller evening schools in its own districts, and it should aim at having such other reasonable attractions, social, athletic, literary, and the like, as will draw the better class of young men and young women to its doors.

In the days which we all hope to see in the near future, when on well-marked rungs of the educational ladder, the Board School child shall be able to work his way from the free Elementary School through the Board Continuation Schools and the Polytechnic to the University, whether in London or elsewhere, the Polytechnic may well be a home, a smaller university and public school, to help our poorer fellow citizens to privilegs which they have not had in the past.

Finally, let me indicate what I think likely to be the main danger of the Polytechnics in the near future. In the first place they should on no account lose their catholicity. If a certain number of students want any particular class (in the Polytechnic at Regent-street the number is 13) they should be allowed to have what they desire if it can possibly be managed. The Polytechnic should aim at attracting all students by affording classes which would give some kind of encouragement to the natural bent of each. It should aim at encouraging the athletes, the cyclist, the cricketer, the literary boy, to join its ranks, so that while practising his favourite sport he may see before him, and utilise, educational advantages which he otherwise would not have thought of.

And if the writer may revert last of all to what he has insisted on in more than one place in this paper, the Polytechnic should be a home from home. It should be as sociable as possible, and as far removed from an academy as it can be made. Those few who guide it should be in touch with as many hundreds or thousands of the members and students as time and capacity will allow.

After all it is the personal influence that goes furthest, and speaking from an experience of nearly 34 years, the writer looks back on the influence arising from personal touch and individual intercourse as being the most potent of the forces which have made the original Polytechnic what it is.

At Regent-street, Mr. J. E. K. Studd has given some 13 years of his life, being present nearly every morning and every evening.

Mr. R. Mitchell, the director of education, is as ready to consider and talk over any point involving sociability or recreation as sympathetically as one referring exclusively to education. There is much more that the Polytechnic may do in this line which has not yet been touched on at Regent-street, or anywhere else. The writer would like to see an arrangement whereby one or two trained nurses would be able to assist and care for country boys lying ill in London lodgings. He would like to see a scheme on a self-supporting basis for lodging young men, somewhat on the lines, *mutatis mutandis*, so successfully carried out by Lord Rowton for a very different class. He feels sure that the more the Polytechnic can do to sweeten and brighten the lives of the young men and the young women of London, the more the educational classes, whether technical or otherwise, will prosper, and the greater will be the hold which these institutes will have on the well-being of the young men and the young women of our great city.

The following Table gives the number of students in the departments of Art, Science, Technology, Domestic Economy, Commerce, and Literature, in the Polytechnics named for the term October-December, 1896. It will be noticed that the figures are not given for the Northampton Institute and the Northern Polytechnic, which were not fairly at work last winter, and no figures have been received from the People's Palace. For the figures contained in the Table, the writer is indebted to the principals of the several Polytechnics :—

Institution.	Art.	Science.	Technology.	Domestic Economy.	Commercial Subjects.	Literary Subjects.	Total.
Regent-st. Polytechnic..	697	2,684	1,902	601	1,602	590	8,976*
Goldsmiths' Institute....	508†	885†	957†	1,112†	2,512†	176†	6,150†
City Polytechnics:							
Birkbeck Institution..	220	1,598	69	67	1,549	581	4,084
City of London College	155	796	81	—	1,155	324	2,511
Battersea.............	250	2,087	560	198	453	137	3,685
Borough (including Herold's Institute)....	82	282	975	256	401	162	2,158
South-West London....	200	603	1,231	111	253	87	2,485
Woolwich............	158	960	38	45	206	34	1,441
Total.........	2,270	9,895	5,813	2,390	8,131	2,091	30,590

* As many of these students attended more than one class, the actual number of class entries at Regent-street Polytechnic was 13,300. † These figures refer to the whole of the previous Session.

The figures given in the above Table do not include music and recreative subjects, and refer to only eight out of eleven polytechnic institutions; except in one case, they represent the entries for one term only, and not for the whole year.

THE WORK OF THE POLYTECHNICS.

By Professor William Garnett.

Secretary and Educational Adviser of the Technical Education Board of the London County Council.

In the paper which he has just read, Mr. Quintin Hogg, the founder of Polytechnics, has given an account of the early history of the Regent-street Polytechnic and of the establishment of the Polytechnic movement in London. He has also set forth very clearly the conception of a Polytechnic and the leading principles which have guided the development of the great institution in Regent-street; but he has overlooked one fundamental point, and in this respect he has followed the example of those who looked upon the Regent-street Polytechnic as the type of the institutions to be erected out of the City Parochial Charities—he has failed to notice that the personal service and life-long devotion of Mr. Quintin Hogg and Mr. J. E. K. Studd, given gratuitously and ungrudgingly, to *the* Polytechnic may be obtained once in a generation, but are not to be secured by advertisement or purchased by public money. An organisation, such as that which obtains in Regent-street, cannot be created by Act of Parliament, or by schemes of the Charity Commissioners, or by the contributions of County Councils. It is the child of the spirit which initiated it, and has attained its maturity only under the fostering care of its parent. Other Polytechnics adopting similar lines of work and exerting similar influences on their members may be carried on when a similar personality can be secured to guide their fortunes, but any attempt to establish such an institution by the machinery of the State would lead to no greater success than that promised to all the king's horses and all the king's men in another connection. The most that can be done by public control is to see that the constitution of a Polytechnic Institute is sufficiently flexible to allow free scope to a Mr. Hogg or a Mr. Studd if such can be found. The Charity Commissioners' scheme for an industrial institute, which now serves as the common basis for the schemes of all the Polytechnics, has secured this freedom, and the Central Governing Body of the City Parochial Foundation and the Technical Education Board of the London County Council, the two bodies entrusted with the administration of the greater part of the funds available for the maintenance of the Polytechnics, have taken care to do nothing calculated to interfere with the freedom thus given.

Every Polytechnic, the buildings of which are approximately complete, possesses its social and recreative departments, and its hall for public entertainments. These departments generally include reading rooms, refreshment rooms, social rooms for men and women, games, rooms, gymnasia, and sometimes separate rooms for the meetings of clubs. All these facilities are open to members of the institute, who, in most cases, are admitted to the educational classes as well as the public entertainments at reduced fees, but in some cases membership of the institute is confined to students of the classes, thus giving to these Polytechnics a distinctly educational, rather than social, basis. The Birkbeck Institution and the City of London College, situate within the precints of the City, possess sites so limited that it has not been found possible to provide upon them all the social and recreative facilities desirable, or indeed the workshop accommodation required by distinctly trade classes, and on this account the Charity Commissioners have federated these two institutions with the new Northampton Institute in Clerkenwell to form the City Polytechnic, and have provided by scheme that the members of the Birkbeck Institution and the City of London College shall be members of the City Polytechnic, and as such shall enjoy the almost unparallelled recreative facilities of the Northampton Institute with its magnificent swimming bath, gymnasium, and great assembly hall.

The funds administered by the central governing body of the City Parochial Foundation and the contributions of City Companies are available equally for educational and for social and recreative purposes, but the funds contributed by the Department of Science and Art and the Technical Education Board of the London County Council can be used only for educational work. The use made of the social and educational facilities of the Polytechnics must depend almost entirely on the voluntary efforts of the members, and these derive their life from the inspiration of a very few guiding spirits among the responsible officers of the institution, but the educational work is more amenable to external organisation and control, and where provision is made which meets the requirements of local trades, successful classes may in nearly all cases be secured.

In order to enable Polytechnics to meet the educational requirements of industrial students, it was necessary not only to provide workshops and class-rooms with adequate equipment but to furnish maintenance grants sufficient to enable the classes to be carried on independently of grants earned on the results of the examination of individual students, many of whom meet with extreme difficulty in attempting to answer questions on paper; while any examination syllabus, however skilfully drawn up, fetters to some extent the freedom of the teacher when attempting to adapt his teaching to the special needs of a particular class of students. The effect of the well-equipped laboratories and workshops of the Polytechnics has been to attract within their walls nearly all the distinctly technical teaching in London, with the exception of that carried on by the City and Guilds of London Institute, and, independently, by a few of the City Companies.

The objects which the Technical Education Board has had in view in its dealings with the Polytechnics have been—

1. To allow to the several governing bodies the greatest possible freedom in the conduct of social, recreative, and even religious work within the provisions of the schemes of the Charity Commissioners.

2. To secure to each Polytechnic the services of an educational principal, who should be responsible to his governing body for the organisation and conduct of the whole of the work of the institution.

3. To provide in each Polytechnic a permanent staff of teachers, who should be heads of their respective departments and give their whole time to the work of the institution, and thus to establish a corporate or collegiate life in the Polytechnic, which would afford an element of

stability, notwithstanding the fact that many of the teachers of special subjects are necessarily engaged only for the conduct of particular classes and cannot be expected to feel that their interests are permanently bound up with those of the Polytechnic.

4. To ensure that all branches of experimental science are taught experimentally, and that the students have the opportunity of carrying out practical laboratory work, at an inclusive fee not exceeding ten shillings for any one subject.

5. To provide efficient workshop instruction in all practical trade subjects.

6. To secure that the number of students under the charge of any one teacher in laboratory or workshop classes, or in other classes in which personal supervision is of paramount importance, shall not exceed a stated limit (fifteen in the workshop or twenty in the laboratory).

7. To exclude from classes students who, for want of preliminary training, are incapable of profiting by the instruction provided, and to this end to restrict the attendance at workshop classes to those who are actually engaged in the trades concerned, and have thus opportunities of acquiring the necessary manual dexterity in the performance of their daily duties.

8. To furnish an adequate fixed stipend for all teachers in place of a contingent interest in fees and grants.

9. To encourage private subscriptions and donations.

10. To establish an efficient system of inspection.

11. To facilitate the advertisement of Polytechnic classes, and especially to invite the co-operation of trade societies in supporting their respective classes.

12. To encourage the higher development of some special branch of study in each Polytechnic.

13. To utilise the Polytechnic buildings as far as possible in the day time by the establishment of technical day schools or otherwise.

14. To secure uniformity in the keeping of accounts.

In furtherance of these objects the Technical Education Board has offered to each Polytechnic :—

(*a*). Such equipment grants as may from time to time be made by the Board for specific purposes on the application of the governing body,

(*b*). A fixed contribution of £1,000 a year,

(*c*). Three-fourths (not exceeding £500 a year) of the stipend of the educational principal,

(*d*). Ten per cent. on the fixed salaries of the teachers,

(*e*). One penny for each hour's attendance of each student, and

(*f*). Fifteen per cent. on all voluntary subscriptions and donations from private sources,

Provided that the total payment to any Polytechnic in any one year under (*b*), (*c*), (*d*), and (*e*), does not exceed £3,000, and under (*f*), does not exceed £2,000.

The Board also makes special grants not exceeding £500 a year towards the cost of providing teaching of an advanced type in some special subjects, such as tanning and leather dyeing, at the Herold's Institute, Bermondsey, a branch of the Borough Polytechnic, and mechanical and electrical engineering at the South-West London Polytechnic. The Battersea Polytechnic is contemplating the establishment of a special department in the chemistry of coal-gas and of oils and fats and some other branches of organic chemistry, and it is possible that electro-chemistry may find a home in the Northampton Institute in Clerkenwell, where steam power to the extent of about 400 horse-power is available.

For the further utilisation of the Polytechnic buildings and equipment during the day time the Board defrays nearly the whole cost of conducting day schools in domestic economy, where girls who have left the public elementary schools obtain half a year's instruction in cookery, laundry, dress-making, and housewifery free of expense, and in addition receive two free meals a day and materials for dress-making classes.

At the Battersea Polytechnic there is also established at the expense of the Board a domestic economy training school for teachers, where free training is given for two years in the teaching of all branches of domestic economy to the nominees of the Board.

The establishment of technical day continuation schools for boys and girls who have passed the sixth standard is rapidly becoming general in the Polytechnics. The Regent-street Polytechnic and the People's Palace have long been provided with day schools, that at Regent-street differing very little in its commercial and science sides from the modern sides of ordinary second grade endowed secondary schools. Battersea Polytechnic and the South West London Polytechnic established mixed schools for boys and girls at the time of their opening, and the Borough Polytechnic and Woolwich Polytechnic are making arrangements to open similar schools next September. The leading idea of these schools is the provision of two or three years training in science, art, and the use of tools, without neglecting the cultivation of literary subjects, for boys and girls who have left the public elementary schools and intend to enter industrial life. The work of the schools is so arranged as to avoid any breach of continuity when a pupil passes from a public elementary school into the Polytechnic day school. The teaching of elementary experimental science forms an important feature in the curriculum of these schools, and at Battersea the boys who have passed through the first year's course are divided into three sections, according as they intend to enter the building trade, the engineering trade, or the chemical trade, and their drawing office, laboratory, and workshop instruction is modified accordingly.

Indirectly, the Polytechnics are aided by the scholarships and exhibitions offered annually by the Board. Apart from the domestic economy schools, which are mainly supported by the Board's scholars, a large number of the Board's scholars and exhibitioners attend the Polytechnic classes; in fact, nearly all the winners of evening exhibitions in science and technology (86 out of 101 recently elected), and a very large proportion of the art scholars and exhibitioners come from the Polytechnics. Last year there were 141 of the Board's scholars and exhibitioners in one Polytechnic.

Another indirect advantage to the Polytechnics is provided by the systematic inspection of classes carried out by the Inspectors of the Board, who include among their number specialists in art and artistic crafts, in science, and in general education.

The system described above has led to a general raising of the level of the education provided by the Polytechnics without sacrificing the interests of the artisan or apprentice, who is encouraged to attend not only the workshop classes but the drawing-office, the laboratory, and the lecture-room, where special classes in such fundamental subjects as workshop geometry, workshop arithmetic, and experimental mechanics are arranged for him. The teaching staffs of the Polytechnics now number many men who have taken high degrees at the universities, including several doctors of science, and the work carried out in the Polytechnic laboratories is not altogether innocent of research. Unfortunately, it is always necessary to face the fact that the middle classes are far more ready to seize upon educational advantages than the industrial classes, and this is a source of danger to the Polytechnics, which calls for perpetual watchfulness.

From what has been said it will be seen that the Polytechnics go very far to fill for the industrial student the gap which exists between the standards of the public elementary school and the university college, or the Technical College of the City and Guilds Institute. The technical day schools link the Polytechnic directly to the public elementary school; the evening classes in science, art, and technology, follow on from the Polytechnic day school, the higher grade school, or the evening continuation school of the School Board; and these with the special advanced day classes lead up to the university college or the technical college, while in some of their more advanced classes the Polytechnics already deal with work of university standard, and among their students are to be counted not only those who will proceed to technical colleges of university rank, but many who are preparing for the degree examinations of the University of London.

The weakest point in the educational organisation of the Polytechnics lies in the provision made for literary instruction. The study of "pure literature" cannot be aided under the Technical Instruction Acts and the Science and Art Department has no funds available for its encouragement. As a result of having no funds specially devoted to their support the literary departments of the Polytechnics have not made the same progress as the other departments. An attempt is now being made to remedy this. The Technical Education Board is not only considering the best methods of aiding the study of economics and other branches of commercial science, but is using its moral influence to encourage literary studies, while the Central Governing Body of the City Parochial Foundation, acting on the suggestion of the London Polytechnic Council, has increased its contribution to the London Society for the Extension of University Teaching in order to enable that society to provide courses of lectures and classes in literary subjects at the Polytechnics.

The total capital outlay represented by the sites, buildings, and equipment of the London Polytechnics exceeds £500,000. The annual cost of maintenance is a little over £120,000, of which about one quarter is provided by the fees of students and members, one quarter by the Central Governing Body of the City Parochial Foundation, one quarter by the Technical Education Board of the London County Council, and the remaining quarter chiefly by City Companies and the grants of the Science and Art Department.

Where there is so much in common it is perhaps scarcely desirable to accentuate minor points of difference, but the times at which the several institutions have been established, the characters of their respective districts, the *personnel* of their governing bodies and their chief officers, and the sources from which they have derived their chief support, have not failed to leave their mark upon the organisation and character of the institutions themselves. The Goldsmiths' Institute, though included in the original scheme of the South London Committee over which Mr. Evan Spicer presided, was ultimately established by the unaided action of the Goldsmiths' Company, and, except for students' fees and grants from the Science and Art Department, has been entirely supported through the munificence of that ancient Guild. Established on the borders of a large residential suburb, the Goldsmiths' Institute, while not neglecting the requirements of the industrial population, is utilised, especially in its recreative and social departments, to a greater extent by the commercial classes than is perhaps the case in most of the other Polytechnics. But to compensate for this peculiarity which is almost incidental to the situation of the institute, the Goldsmiths' Company have recently established a branch institution near the river in Deptford, on the premises of Sayes Court, kindly placed at the disposal of the Company for that purpose by Mr. Evelyn, and in this institution special provision is made for the artisan and poorer classes of Deptford, in the hope that after attending classes at Sayes Court for a year or two they will be induced to take advantage of the still greater facilities which are offered in the Goldsmiths' Institute itself.

The Birkbeck Institution and the City of London College were established many years before public money was available for the work of such institutions and before the Polytechnic schemes had been thought of. As a natural consequence the social and recreative facilities which these institutions afford, àre entirely subordinated to their educational work, and the sites and buildings do not enable greater facilities to be provided. The City of London College has been especially renowned for its commercial side, while in chemistry and some other branches of experimental science, it has done excellent work. The Birkbeck Institution has made a special feature of economics, and of chemistry, physics, biology, and other branches of science, which have been taught in it very largely on a university footing. When, therefore, these institutions applied to the Charity Commissioners to be treated as Polytechnics, a grant was made to them from the funds of the City Parochial Foundation, as above stated, conditionally upon their being federated with the new Northampton Institute on which was thrown the obligation to provide recreative and social facilities as well as workshop classes for the students of all three institutions. Hence it follows that the Northampton Institute itself is in a somewhat exceptional position. It is threatened with hypertrophy of the social and recreàtive department, while on the educational side it is under agreement with the Birkbeck Institution, and the City of London College, not to establish, at present at any rate, any classes in science, art, or commercial subjects of the same kind as those conducted by the sister institutions. Its educational work is, therefore, almost entirely confined to workshop classes in the building trades, in mechanical engineering and the metal trades, and in artistic crafts, with instruction in those branches of science and art which are directly associated with, and spring out of, workshop instruction, while on the women's side, the institution has an unlimited field in the conduct of domestic economy classes, as well as classes in those trades which are specially adapted to women's work: an ample field, assuredly, but one which requires more careful cultivation than that of the Science and Art School.

The early history of the People's Palace was of a somewhat chequered character, but the institution was saved to the East-end by the liberality of the Drapers' Company. In consideration of their promised grant of £7,000 a year, the Charity Commissioners liberated the institution from the control of the Central Governing Body, though still permitting it to enjoy the income from the City Parochial Foundation provided for it under its original scheme. In this institution the educational department was at first little more than an appendage to the social and recreative side, and the main feature appeared to be the Queen's Hall, in which public entertainments on a very large scale were organised. The educational side, which comprises the Organised Science Day School and the East

London Technical College, has now grown to such proportions as to have assumed much greater importance than the social side itself, but the two departments have been kept almost wholly separate, and the students of the Technical College, as such, have no privileges in connection with the entertainments or social side of the institution. In its complete independence of the educational and recreative departments the People's Palace is unique among the London Polytechnics.

The district in which the Borough Polytechnic was established at once gave character to the work of the institution, and this was accentuated by the appointment of a principal whose great strength lay in the organisation of workshop classes for artisans, and of the instruction in science and art incidental thereto. As a result the workshop classes in the Borough Polytechnic bear a larger proportion to the total work of the institution than is the case in any other kindred institute, while the social side forms a very important feature, which, though less independent of the rest of the work of the Polytechnic than is the case at the People's Palace, is less intimately connected with the educational department than is the case in most of the other Polytechnics.

At Battersea the building, engineering, and chemical trades necessarily come very much to the front. The Polytechnic possesses two excellent gymnasia, one for men and one for women, but the recreative side is made subject to the educational side, inasmuch as only those students who are attending some classes in the Polytechnic are allowed to be members, and enjoy the social and recreative facilities which the institution affords. In this respect the example of the Battersea Polytechnic has been followed by the South-West Polytechnic at Chelsea, and by the Northern Polytechnic at Holloway, though, through the incomplete character of its building, the social department of the Northern Polytechnic at present consists of little more than a nucleus. At Chelsea the nature of the district has given a great spur to classes of a more advanced character, and the Polytechnic resembles a provincial university college to a greater extent perhaps than any of the other London Polytechnics.

The importance of the social side at the Regent-street Polytechnic has been dwelt upon so fully by Mr. Quintin Hogg in his paper, that it is unnecessary to do more than refer to it here. On a smaller scale the organisation of the Woolwich Polytechnic very much resembles that of the Regent-street institution. The proximity of the Royal Arsenal and other great engineering works give an essentially North Country character to the Woolwich Polytechnic, and when funds have been raised for necessary buildings, it is probable that Woolwich will possess one of the best engineering schools in London.

But for the paper just read by Mr. Quintin Hogg, a description of the work of the Regent-street Polytechnic, by far the largest educational institution in London, would have formed a very considerable portion of this paper, but the description has been given by the author of the institution itself, and it is only necessary here to remark that, notwithstanding the great development of its social side, the educational work of Regent-street Polytechnic compares favourably with that of any other institution in London.

Reference has been made in this paper to certain departments in which the educational work of the Polytechnics is, or is likely to become, work of university character. It is not possible in this country to draw a distinct line between secondary education and university education. In most universities and university colleges much of the teaching is of a preparatory character, and at Oxford and Cambridge especially no inconsiderable portion of the students are far below the standard of the highest form in our best secondary schools. Perhaps, as the promoters of university extension contend, the real test of university education lies rather in the manner of the teaching than in its advanced character. But it is not on the strength of distinctions of this kind that it is said that some of the Polytechnic teaching is of university type. Whether tested by the attainments of the teachers, the manner of the teaching, the equipment of the departments, the proficiency of the students, or the advanced character of the subjects taught, which in some cases belong rather to post-graduate than to pre-graduate study, certain branches of the Polytechnic work can establish their claim to university rank. It does not follow that the Polytechnics themselves are to be regarded as university institutions any more than that the University of Cambridge is to be treated as a public elementary school because some of its students attend classes in arithmetic and the first three books of Euclid. University College, King's College, Bedford College, the Royal College of Science, and last, but not least, the Central Technical College, are institutions in London of recognised university rank, and the first three may be regarded as fulfilling the functions of university colleges in nearly all the faculties. It is not likely that any of the Polytechnics will put forward claims to be similarly regarded, and it may well be doubted whether they could do so without departing from the special mission which they are established to fulfil; but the colleges of recognised university rank do not provide the whole of the university teaching of London. In economics, a very large share is supplied by the London School of Economics and Political Science, in one of the rooms of which Section B is now meeting, while in special branches of science the Polytechnics will each year afford more and more of the higher teaching; and it is right that this should be so, nor need the the higher colleges fear any undue competition. It is impossible that three or four institutions should supply the higher technical training for four millions of residents besides a very large number of students imported from the provinces, or should be able to deal with all the applications of science which ought to be taught in London when the higher teaching receives due recognition and its function is properly understood. Electro-chemistry will before long require a college to itself. The many branches of civil engineering cannot possibly be accommodated in any one of the existing institutions, and mechanical and electrical engineering are in nearly the same position. By each Polytechnic selecting some special subject in which to develop a department for higher work the general character even of the elementary work of the institution will be improved, while no university which professes to meet the educational requirements of London can be considered approximately complete if the Polytechnics do not receive some recognition in its scheme of organisation.

The CHAIRMAN said that as Sir John Lubbock had to leave he would call upon him now to make a few remarks.

Right Hon. Sir JOHN LUBBOCK, Bart., M.P., said that, as a Londoner, he was extremely glad to have the opportunity of saying how very deeply they were indebted to the readers of the papers to which they had all listened with so much interest. He was sure he was expressing the opinion of everyone in London when he said how much they owed to Mr. Quintin Hogg for the great and useful work he had done in connection with polytechnics. Mr. Hogg, in his paper, had paid a tribute of respect to Mr. Anstie, who had an extremely difficult task before him, and he (the speaker) thought the manner in which Mr. Anstie had succeeded in utilising the parochial funds for the benefit of higher education in London was a matter for which everyone was greatly indebted to him. He was afraid we did not always appreciate the importance of the work, and he was glad it had been recognised by the reader of the paper. The London County Council had been blamed for being rather slow in applying the funds entrusted to it for the purpose of technical education, but they felt it was a great responsibility, and it was not from any want of appreciation of the importance of the trust imposed upon them, but they felt it was much better to go a little more slowly, and to feel more sure of their ground than to spend all the money at once without giving the matter the full attention and consideration which it deserved. They had been gradually increasing the amount which was being spent for educational purposes, and in a very short time he believed the whole amount of the funds would be employed for the purpose of education. There were one or two points in which he confessed he was not quite sure that the County Council was altogether going in the right direction. Mr. Garnett had told them that one quarter of the £120,000 which was being spent annually on technical education in London came from the County Council grants. But, of course, that was by no means the whole amount which was being spent on education by the London County Council out of the funds entrusted to it by Parliament. The Board which controlled these matters was ably presided over by Mr. Sidney Webb, but he (the speaker) would like to throw out the suggestion that they were perhaps voting rather too much of the fund to assisting children in going up to higher schools, and rather too little to the polytechnics and other educational institutions. He hoped no one would suppose that he did not value the increase of the means by which the younger children of our poorer fellow countrymen might have the opportunity of scaling the ladder, still, they had to balance the relative advantages, and although he did not know that he should go quite so far as Professor Thompson when he said that one great chemist was worth all the advantages given to children who attended evening classes, still he (the speaker) did think that we were somewhat neglecting the higher training of those who were to be the leaders of the army of industry. There was a great tendency not only in educational matters but in all other matters to go from one extreme to the other. At one time education was considered almost entirely from a literary point of view. He was one of those who had endeavoured to impress upon our countrymen that literature was not the whole of education—though, of course, it was an important part. The man who had merely studied languages to the neglect of science and other things could only be said to have half an education. Still, he rather regretted that the large fund which had been set free by Parliament should be devoted entirely to technical instruction; he hoped it would be devoted to higher education generally. Professor Thompson said that it was a mistake to suppose technical education was anything the Science and Art Department could make it. That was, however, the legal definition of technical education in this country—anything said to be technical education by the Science and Art Department was for all legal purposes technical education. That was unfortunate, for it altogether confused what technical education really was. Technical education could not properly be strained to include all that was taught under the Science and Art Department. He wished also to say a word with reference to a remark in Professor Thompson's paper in which he referred to the chemical education of bricklayers. Professor Thompson referred to the late chairman of the London County Council, and deprecated the remark made by him in which he advocated the teaching of chemistry to bricklayers. Professor Thompson went on to say:—"What is wanted in the education of a bricklayer is not a pernicious smattering of chemistry, which is out of the range of his work, though germane possibly to the trade of a brickmaker, but a widening of the training of the bricklayer in his own craft." He (the speaker) rather hoped Professor Thompson would modify the reference to a "pernicious smattering." No doubt a smattering of anything was useless, while on the contrary a good grounding was most desirable. He did not see why a bricklayer should not have a grounding in the principles of chemistry. In that he hoped Professor Thompson would agree with him. We ought to give to all who are going to our higher schools a thoroughly sound and wide foundation, although with regard to detail we could not carry it very far. He thought we could congratulate ourselves in London upon what had been done, and what was being done. He had ventured on these few words of criticism because what brought them together was rather that they might learn from one another, and not that they might express opinions on which all were agreed. Personally, he thanked Mr. Quintin Hogg and Professor Garnett for their papers, and he thought all were indebted to them, not merely for their interesting papers, but also for the great services they had rendered, and were rendering, to the cause of education.

REFORMS IN THE ORGANISATION OF TECHNICAL EDUCATION.

By Prof. Silvanus P. Thompson, F.R.S.

"Recreation is not education, and social betterment is not the same thing as educational progress. Success in answering questions set in a paper is at best only a paper success; and education which is not technical is not technical education." These are the concluding words of a paper on the organisation of Technical and Secondary Education, read to the Society of Arts by the present writer on February 19th, 1890, at a critical time in the movement. Of the three reforms which those words adumbrated, one—the system of payment by results on written examinations—a system disastrous to all true technical teaching, has received its death warrant. But other reforms remain to be carried out. Indeed, there is hardly a line of what the author wrote in 1890 of which he would not urge the cogency to-day. There is still much need of the cold steel of common sense to divide the true from the sham; to discriminate between things which, though essentially different, are called by the same name; to get rid of statistical nonsense, in which progress is supposed to be indicated by the number of thousands of persons taught, irrespective of the questions as to what or how thoroughly they are being taught; and, lastly, to clear away some of the burdens cast on the technical education movement by enthusiastic but muddle-headed pioneers. A few only of these reforms can be touched upon to-day.

The first reform needed in technical education is get rid of the misuse of the term whereby it is applied to various kinds of education about which there is nothing technical whatever. In a certain town in the North a course of lectures upon Dante and the history of Florence was given at the expense of the technical education grant. While one rejoices at the spread of culture and envies those who met week after week to hear the brilliant scholar who delivered these discourses, one must protest against the notion that they have anything to do with the promotion of the arts or industries. Education of a young artisan or craftsman in the scientific principles underlying his craft, or in the technicalities of his particular industry, is one thing: education of the dilettanti by lectures on a picturesque figure in history is quite another matter. Yet how often is the term technical education misapplied. Many use it as if it were synonymous with anything that can be taught under a County Council grant or under a South Kensington syllabus. They forget that the right use of the term depends not only on the subject taught, but on the person who is being taught. If you get hold of a young photographer, and teach him the scientific principles, optical, chemical, and artistic, of his craft in a proper photographic laboratory, that is real technical education. But give the same course of instruction in the very same laboratory to a young builder or to a young silversmith, or to a young silk-weaver, it is not technical education at all. It has nothing to do with his trade or industry. Education is technical only so far as it is directed to the training of the individual in and for his business in life. Education, I repeat, which is not technical, is not technical education.

The next point in which reform is needed, and in which it is slowly but surely coming about, is the proper adaptation of the technical training to the needs of the various industries or groups of industries. The sort of training that is right and appropriate in one trade or group of trades may be quite wrong and inappropriate in another. Technical education means a different thing in every trade or group of trades. Take the following cases. In certain handicraft industries, such as that of the zinc-worker, every man must be a skilled workman. He needs, besides a large amount of experience to be gained only in the craft itself, a certain knowledge of geometry of a particular kind. He must know something about the properties of metals, about soldering, about corrosion and its prevention. The acquisition of this knowledge does not necessitate many years of study, nor compel attendance in any very expensive laboratory; but every man must get something of this training. Take by way of contrast the technical training required in one of the chemical industries, such as that of the manufacture of dye-stuffs. The work in this industry is carried out by a few highly-trained chemists, an engineer or two, and a large number of unskilled labourers. The industry depends in no way upon the training of the labourers. It would not be benefited to any perceptible degree by opening evening classes in chemistry for them. On the other hand, its success is vitally bound up in the possession of a few properly-trained chemists—men who have devoted three or four years at least of their lives to studying chemistry in properly-equipped laboratories. Contrast these two cases—the most extreme that occur to me. In one industry the right and appropriate sort of technical education is the training of the many by a species of not very advanced instruction, which can readily be carried out in any evening continuation school where a room can be spared for a workshop and where a teacher can be found who is himself a skilled metal worker, well trained in geometrical drawing. In the other industry the right and appropriate sort of technical education is the high training of the few in an elaborate course of study, conducted in laboratories expensively equipped and provided with appliances for research, and to which several years are continuously devoted. Either kind of education would fail to meet the needs of the other industry. The man who had spent three years in the continuous study of the higher geometry would find no place in the zinc-working industry; while the chemical factory has no use for the smatterer who has only picked up the bare elements of chemistry in evening classes. The statistics sometimes paraded to show how many hundred or perhaps thousands of students are receiving evening class instruction in chemistry, gratifying as they may be in showing the progress of modern education in science, have really nothing to do with technical education or the development of the chemical industries of the country. One thoroughly highly-trained research chemist is worth them all. What provision is made on the Continent for this higher training in chemistry may be seen from the fact that the entire establishment of the Regent-street Polytechnic, chemical laboratory, gymnasium, swimming bath, theatre, kinematograph, and all, might be accommodated within the space provided for the chemical laboratory alone in the Polytechnic at Munich. The chemical laboratory of the Polytechnic at Zürich exceeds in contents the whole of the technical schools at the People's Palace. The chemical laboratory of Berlin is larger than the whole building of the City of London College. The physics laboratory at Zürich is considerably larger than the whole building of the Finsbury Technical College, and the cost nearly twice as much. They do not play at teaching chemistry in Germany and Switzerland, and their laboratories are frequented by earnest students. Students will remain three, four, or five years in these laboratories to work at research.

And yet, with simple facts such as these staring them in the face the builders of our technical schools and organisers of our schemes of technical instruction seem to have imagined that at every centre of artisan education there must be a chemical laboratory, and that the chemical industries of England were to be regenerated by evening chemical classes for artisans. The first sign of reaction against this extraordinary blunder is to be seen in the recently published report of the special Sub-Committee of the Technical Education Board of the London County Council; who after taking the evidence of a number of qualified experts, reported with regard to secondary and continuation schools that the teaching of chemistry "should be solely of an educational nature, and should have no reference to practical applications," but that "for the training of chemists who are to advance the industries of the country a prolonged course of study in the elements of physics and chemistry and in the methods of research is needed;" while for certain localised industries such as tanning, leather-dyeing, waterproofing, &c., in which chemical processes are employed, they recommend that the teaching should be concentrated "in a small number of institutes which should be thoroughly equipped for the purpose and placed under the direction of technical experts." In other words the sub-committee tell us that a complete reform is needed so far as the teaching of chemistry is concerned in our technical institutes, that in the chemical industries only the most highly-trained chemists are wanted; and that in the allied industries, like tanning, special establishments or *mono-technic* institutes are preferable.

There are of course other industries which occupy places intermediate between these two extremes. In engineering there is wanted the kind of technical education which makes the skilled fitter, the skilled pattern-maker, the skilled turner, and the skilled draughtsman. But over and above this there is wanted the highest kind of training for those who are to manage and push forward the industry; and this training must necessarily be conducted in properly-equipped establishments, requiring the devotion of two or more years of continuous study, and for which evening courses of instruction are—save in the case of most exceptional individuals—wholly inadequate. It is obvious that the highly specialised and highly-equipped institutions suitable for the second of these purposes can only exist in a few places. Great municipal technical schools like those of Manchester and Birmingham, and important local London technical Institutes which, like that at Battersea, lie in an engineering centre, must contemplate providing for both kinds of engineering education. In some other towns there is a University College which supplies the higher engineering work; and in such cases it it simply a waste of energy for a second institution to attempt to specialize in this branch. In the textile industries again a high degree of specialisation is necessary: to train every mill-hand in the mechanics of textile machinery or in the technique of textile design is simply useless. Here and there an individual of unusual capabilities may be found; and in a wisely organised system means will be provided to train and develop special talent. The greatest difficulty in the way of such development arises out of the too often imperfect general education of the individual who shows special technical abilities.

Another most important reform is that of so utilising the facilities for instruction as to develop breadth of view and capacity in those who are trained. This is all the more vital to the future of this branch of education because of the extreme and in many cases disastrous degree to which the subdivision of labour has been pushed in many of the handicraft trades. Formerly the apprentice learned a whole trade; he journeyed about to pick up the outlying branches and widen his experience before he could become a master. Nowadays the apprentice commonly learns under a master who practises but a part of a trade, and he himself is taught only one portion of that part. In the cabinet-making industry, and in many of the metal industries, the result is deplorable. Men grow up capable of doing but one thing, and are dependent upon a wholly different set of men or upon several different sets to finish what they have begun, or to begin the work that they receive for a subsequent stage in the process. The all-round competent hand grows rarer, and trade suffers, and workmen suffer, at every change of fashion. If judiciously directed, technical education may do much to alleviate this sad effect of the capitalist tendencies of the past. It ought to be the incessant aim of the organisers of technical schools and classes to broaden the basis of the instruction, and to fight against the narrowing tendencies abroad. But this must not be done without discrimination, otherwise it ends in absurdities. A little more than a year ago I listened to a speech on technical education by no less a person than the late Chairman of the London County Council, in which he advocated the teaching of chemistry to bricklayers on the ground that it would be an advantage to the bricklayer to know something about the chemical causes of the differences of colour in his bricks. A grosser caricature of the aim and end of technical education could scarcely have been invented. What is wanted in the education of a bricklayer is not a pernicious smattering of chemistry, which is out of the range of his work, though germane possibly to the trade of a brickmaker, but a widening of the training of the bricklayer in his own craft. How few bricklayers know how to do tuck-pointing? How few understand properly the different kinds of bonding? How few have ever learned the simplest elements even of brick-cutting? These things they might with great gain learn, as being things truly pertinent to the technique of their industry, and as such will be taught in every well-organised building-trades school. Take again the case of the silversmith's craft. How rarely, in the modern ultra-division of labour, can the all-round man be found. The chaser can chase but not engrave, the engraver can engrave but not chase; neither chaser nor engraver can do the simplest bit cf enamel work, and neither chaser, engraver, nor enameller, can do metal-spinning or silver-casting. Yet here, one would have thought, in an essentially artistic trade, was the chance for rearing good all-round craftsmen. It is cheering to learn from the recent report of the Technical Educaticn Board (1896-7, p. 8), that at the Central School of Arts and Crafts lately established, the subject of gold and silver-smith's work has been taken up "essentially as an artistic craft." "Every effort," they say, "is made to give students a broader view and practice of the craft in which they are engaged." These golden words might well be the motto of all technical instruction. It is to hoped that it will soon be made compulsory for every technical student to take at least one accessory subject beside the immediate one concerned in his actual employment. Thus every silver-chaser might be required to learn also either engraving or enamelling; every bricklayer to learn either brick-cutting or that part of plastering that is common to the two trades of plasterer and bricklayer; every plumber should also learn lead-bossing and lead-burning. I cannot conceive of any more helpful thing to the prosperity of workmen than such a widening of their experience.

This again suggests another reform urgently needed in the organisation of technical instruction, particularly in London, namely the proper selection of subjects taught in the several technical institutes, so that they shall each be developed to the utmost without interfering in one anothers' work. Admirable as the idea of a poly-technic may be, as an idea, there is no question that good and sound technical instruction flourishes better in the school of mono-technic than in that of poly-technic type. Who attempts one thing well succeeds better than he who attempts everything and dabbles all round. Not one of the London Polytechnics is to-day doing as much for any industry as the tanning school is doing for the tanning industry in Bermondsey, or the leather trades' school is doing for the Bethnal-green industry. Very wisely the Borough-road Polytechnic has refused to attempt all sorts of so-called technical classes, and has concentrated itself on certain groups of trades. So also the Bolt-court School is doing an admirable mono-technic work for the printing and lithographic industry. The Shoreditch Municipal Technical School has wisely pushed its cabinet-making classes. The Battersea Institute excels in its engineering side. Without going further one may hail this tendency as a most hopeful sign. Each institute must find its own appropriate work and do it, otherwise it will inevitably drivel away in the sensations of Pepper's ghosts and diving bells, or whatever may be their modern equivalent in scientific toys. All this points to proper adaptation to the local industries as a desirable line of reform. We shall need more schools than at present we have, but they will be schools where the work is better, more serious, more sincere. A technical institute for training reporters and journalists, and a school of foreign tongues for teaching the spoken languages of the world might well be added to the mono-technic institutes of London.

Lastly, we have got to learn how to discriminate between education which is purely secondary on the one hand, and that which is purely "universitary" on the other hand, as against that which is truly technical. It will be an evil day if ever the technical institutes, whether mono-technic or poly-technic in type, neglect their proper work and take to "preparing" their students for university degrees. If they are giving a training that is really of technical value, then their certificate of that training will be more valuable to their students than any University degree. If technical institutes cannot make their training of more use to their students than the holding of a B.A. degree, then that training stands self-condemned. As explained above, chemistry is almost the only subject in which the technical training and the universitary training are really comparable, and the technical training in general goes far beyond anything required for a mere degree examination. In no other subject does the proper work of a technical institute run along the lines of a degree preparation. If it were made a rule in the day departments of our technical institutes to admit no student who had not already matriculated into the university, the case might be different. Yet this suggestion is hardly within practical range. If such a rule were possible, how marvellously it would quicken the educational work of those institutes. In this connection it is well to remember that the "Abiturient" examination required as a preliminary before entering a German polytechnic is vastly more severe than an English matriculation. How many students in a London polytechnic have, before entering, shown that they can pass an examination in differential and integral calculus? In Germany—and there is no mistake about it—the polytechnic schools are places for serious and responsible educational work. They do not, it is true, teach playing; neither do they play at teaching. If we wish our technical institutes to do as much for English industries as the Continental polytechnics have done for Continental industries, let us learn one thing from them. Let us make the serious instruction of the day classes accessible to all by its cheapness, while excluding the incompetent by entrance examinations suitable to the standard attained in our existing secondary schools.

EVENING SCHOOLS.

By Swire Smith.

Member of late Royal Commission on Technical Instruction.

At a Conference of the Mechanics' Institutes of Yorkshire in 1886 I read a paper on the above subject in which I made the following statement:—

> "The magnitude of this question of evening schools expands illimitably the more it is considered, and yet if earnestly grappled with it offers the most practical and economical solution of the problem of the technical education of our artisans. There is no country in the world in which evening classes are so necessary, and can be so usefully and cheaply conducted as in England. There is no country in which they can be so conveniently attended; in no country have young persons engaged in manufacturing pursuits so much leisure."

Educational Conditions Ten Years ago.

The ten years since 1886 have been years of great educational activity. The Royal Commission on Technical Instruction had presented its report to Parliament two years previously, and the recommendations contained in it were beginning to lay hold upon the public mind. In giving practical shape to the conclusions at which we had arrived after inspecting the schools of other countries, and inquiring into their influence upon the manufacturing industries which they had been designed to promote, and after making ourselves thoroughly acquainted with the educational organisations of this country, and their effect upon the occupations of the people, we made certain modest recommendations which at the time were considered by many educational enthusiasts to be altogether inadequate to meet the requirements of the times. We were of opinion, however, that it was better to ask for a little, with a chance of getting it, than to ask for much and have the favour refused. At that time the subject of drawing, which an education minister had graphically described as "the mainspring of the technical education of the artisan," was not taught to more than one in four of the scholars in elementary schools, and that often so badly as hardly to be worthy of the name of instruction. Elementary science fared even worse than drawing. Modelling was almost unknown; manual instruction had scarcely been heard of—the pen was the only industrial weapon that boys intended for skilled handicraftsmen were taught to use—and domestic subjects for girls, excepting needlework, had not come within the range of practical education. The local authorities, however much they might have desired it, had no power to appropriate any of the ratepayers' money towards the development of the brains of the ratepayers in the way of providing technical instruction or contributing to technical schools.

Recommendations of Technical Commission.

The recommendations of the Commissioners dealt with the above and many other deficiencies, and it is very satisfactory that several of them have been adopted. Drawing is now taught to all boys, and usually with the aid of suitable casts and examples; modelling has been introduced in many localities; school museums have been established, and elementary science is now extensively taught with, in some instances, laboratory practice. Manual instruction is being given in the most progressive schools, and in agricultural districts the facts of agriculture are being taught, to which has been added the use of tools with practical instruction in garden plots. In addition to drawing and needlework, the elements of cookery and household management are being taught extensively to girls. The above subjects influence the prospective life work of the scholars, and prepare them on becoming apprentices to take up in the evening classes the special subjects of science and art which have a bearing on their daily occupation.

TECHNICAL INSTRUCTION ACT.

But the most memorable and effective impulse to technical education and evening schools has been given by the passing of the Technical Instruction Act of 1889, which enables local authorities to the extent of 1d. in the £ to build and maintain technical schools and contribute to technical evening schools out of the rates. This was followed by the Local Taxation Act of 1890, which practically handed over certain of the profits of the Excise, amounting to about £750,000 a year, to the County Councils and County Boroughs of the country, empowering them to devote, if they were so disposed, the whole of the funds towards the promotion of technical instruction. The embodiment of these simple Acts into practical legislation is silently working a revolution which is already most favourably affecting the civilisation and industrial efficiency of all who have been brought under its influence. England is proverbially slow in the adoption of reforms, but it is satisfactory to state that already 172 municipalities and local authorities, including London and others of the largest cities, have adopted the Technical Instruction Act, while of 126 County Councils and County Boroughs in England and Wales, 111 have devoted all their funds derived under the Local Taxation Act, and 13 the larger part to that purpose, the amount last year being £724,000. The County Councils of the agricultural as well as the manufacturing districts, where in many instances not the slightest interest had been taken in technical instruction, are devoting themselves to their new duties with conspicuous energy, and although as was inevitable some mistakes have been made, there are many instances of most gratifying success. The public authorities that are entering upon this business are "learning by doing," and among them there is an encouraging spirit of co-operation and of friendly rivalry. The County Councils in many instances have followed their own methods without any general organisation in allocating the funds at their disposal. The most advanced have organised their areas somewhat on the model of the Science and Art Department of South Kensington, with responsible local committees, giving grants on buildings and apparatus, attendance, examinations, lectures, &c., and providing scholarships with maintenance, enabling painstaking students of the artisan class to pass from elementary day or night schools to the highest technical and university colleges. Others have distributed the grants according to population —leaving the administration of them to the various local authorities themselves—a more doubtful proceeding. Concurrently with the beneficial assistance of the county authorities, there has been an increased demand upon the Education and the Science and Art Departments, the latter of which has recently issued a new code of regulations for evening continuation schools, embracing literary subjects, languages, science and commercial subjects, covering the whole field of preparation for those in search of useful or refining knowledge. The above agencies co-operating with the School Boards, Voluntary School Managers, the Recreative Evening Schools Association, and the Society of Arts, guided in many instances by the National Association for the Promotion of Technical and Secondary Education, have put new life into the evening continuation schools of the country enabling vast numbers of young people to rescue their school knowledge which was in many instances rapidly disappearing, to make it distinctly available as a help to the business and pleasures of life.

TEN YEARS OF PROGRESS.

The following figures from the report of the Recreative Evening Schools Association indicate the progress of evening schools during recent years :—

	Year.	Schools under inspection.	Scholars on register.
	1886	841	42,423
	1896	4,347	298,724
Drawing was taught in elementary day schools as under :			
	1886	4,446	870,491
	1895	20,506	2,229,718

Under the Science and Art Department the total number of students under instruction in science, art, elementary drawing, and manual instruction was in—

Year.	Students.
1886	1,046,793
1895	2,641,388

These figures give evidence of great progress during the last 10 years, amounting to a sevenfold increase in the scholars of ordinary continuation evening schools, and to more than two-and-a-half times the number of students in science, drawing and manual instruction under the Science and Art Department.

There are 70 new technical schools, which have recently been opened, involving an outlay of £768,000. There are in addition 67 schools in course of erection, or about to be erected, of which 55 are estimated to cost £756,000, the total being 157 schools, and representing an expenditure of £1,524,000. Another indication of the development and increasing popularity of this movement is to be found in the fact that the State expenditure on education, which amounted in 1872 to £1,077,894, in 1895 reached the sum of £7,644,885.

CITY AND GUILDS OF LONDON INSTITUTE.

A great impetus was given to technical instruction, especially in the manufacturing towns, beginning in 1876, by the organisation of classes, and by practical examinations in the application of science to the industries of the country by the City and Guilds of London Institute, comprising the Worshipful Companies of Mercers, Drapers, Fishmongers, Goldsmiths, Merchant Taylors, Vintners, Clothworkers, Leathersellers, Carpenters, and others, which have taken such a generous and cordial interest in the promotion of this Congress.

The technological classes of the institute are held in 63 subjects representing as many trades, in which practical instruction is being given. In 1886 there were 329 classes, with 7,660 students, and in 1896 there were 1,128 classes, with 26,609 students. The increase in the attendance is not more remarkable than the improved quality of the instruction and the higher standard of the examinations during the period.

By their organisation of the above classes and by their splendid contributions to the People's Palace, and the polytechnic institutions of the metropolis, their erection and maintenance of the Finsbury Technical College, the South London School of Art, and above all of the Central Technical College for the training of engineers, industrial chemists, and technical teachers, these London livery companies have rendered invaluable service to thousands of students, and have thereby most favourably influenced the industries of the country.

CLOTHWORKERS' COMPANY AND TEXTILE SCHOOLS.

Nor can I, as coming from Yorkshire, abstain from acknowledging the great public services rendered by the Clothworkers' Company to that county. It is now more than twenty years ago, at a time of great depression and suffering among the textile industries that the Clothworkers' Company, of London, conceived the idea of rendering practical assistance to the wool industries of Yorkshire. Successive masters and leading spirits of the company, with the untiring assistance of their esteemed and public spirited clerk, Sir Owen Roberts, made frequent visits to West Riding towns, where they were brought face to face with the difficulties of manufacturers and operatives in meeting the competition of their continental rivals. They recognised that the weakness of our position was not due to inferiority of machinery, or of manual skill, but rather to the scientific and artistic knowledge of the competing foreigner which could only be permanently overcome by "finer knowledge" on the part of the Englishman. They, therefore, boldly and generously challenged the public spirited men of the various manufacturing centres with the offer in each instance that in proportion as they would help themselves in the erection of suitable buildings for technical instruction they would help them, not only by grants to the buildings, but by annual subsidies towards their maintenance. And what was the result? The challenge was accepted by every manufacturing centre in the county, and it was to this practical initiative that the woollen and worsted manufacturing towns of Yorkshire owe their technical schools, and to the same cause the recent progress of the wool industry is largely due. But their wise and far-seeing generosity did not stop here. At their own cost they built and equipped a central textile college as a department of the Yorkshire College at Leeds, with all the practical as well as the theoretical aids to the complete instruction of those intended for the textile industries. The new laboratory for dyeing research, which, without regard to cost, has been furnished with the most modern appliances for the prosecution of original research and for the conducting of experiments, bids fair to institute a new departure in the invention of colours and in their application to textile fabrics. In the necessary provision for the higher instruction of those engaged in the manufacture of textiles, in which this country has been so lamentably inferior to its continental neighbours and has temporarily lost some of its best business in consequence, the Textile College at Leeds stands forth as a noble institution, offering facilities for the highest technical training in the departments of weaving, dyeing, and finishing, which, so far as the wool industry is concerned, are not surpassed by those of any similar institution in the world. I am glad to be able to express the testimony of the best authorities to the fact that at the present time the wool industry of Yorkshire—both the woollen and worsted branches—is fairly able to hold its own against its competitors, and if it cannot be said that this result may be credited, entirely to the technical schools, so generously supported by the Clothworkers' Company, it is certainly due to the improvements in designing, dyeing, and finishing of the goods, which it is the aim of the schools to promote, and to the greater skill, efficiency, and energy of those engaged in the trade.

SUPERIOR EQUIPMENT OF CONTINENTAL COUNTRIES.

The general provision for technical instruction in this country especially in the higher branches, is as yet incomparably inferior to that of the leading continental countries. We have neither the buildings, nor until recently have we possessed the legislative means of obtaining the necessary financial aid, but perhaps at the present time our greatest inferiority is in the lack of preparedness on the part of the great bulk of the scholars when they leave the day schools.

The humiliating confession was recently made by the president of the National Union of Elementary Teachers that with a register of 5,326,000 children last year, the average attendance was only 4,346,000, and that practically two-thirds of the scholars (many by having passed the exemption standards of the local authorities, and many more by evasion of the school laws) leave the school at the age of eleven, when their real education can scarcely have begun, and at a time when technical instruction, if offered, can hardly be understood by them.

All our efforts to bring the masses within reach of higher instruction, either in day or evening schools, will be seriously retarded while this state of things exists, and it should be the first duty of all patriots to combine in so strengthening the school laws that no scholar will be permitted to leave the day school under thirteen unless there are exceptional and satisfactory reasons for exemption. It would appear that less than one-sixth of the children remain after twelve, including the half-timers, who, on passing an easy examination at the age of eleven, are allowed to work half-day in the factories till thirteen or fourteen, on condition that they attend school on the other half.

HALF TIME SYSTEM.

My own experience of evening schools has been obtained in the manufacturing towns of Yorkshire, where many of the children pass through the day schools as half-timers from 11 to 13. The system is practically confined to the textile manufacturing districts of the United Kingdom, and enables boys and girls who have passed a standard fixed by a local authority, to enter a factory at 11, working half the day, and attending school the other half till they reach 13, or failing to pass the fixed standard, till 14. The system is condemned by schoolmasters and by philanthropists generally, and therefore I would like, as a practical business man, to describe it as fairly and impartially as I can. I have been associated with half-timers during the whole of my commercial life as a worsted spinner, as an employer of half-timers, and as a member for many years of one of the most progressive School Boards of the country dealing with their education. As an organiser of the evening classes of the Keighley Institute, and from being associated with many of the important technical schools of Yorkshire, I have been brought into constant contact with apprentices and workmen who have passed through the day schools as half-timers, and being an ardent believer in the importance of their better education, for many years my firm have paid half the fees of all operatives attending evening classes. From an educational standpoint, I am of opinion that a boy or girl attending school continuously from 5 to 13, obtains a better education than if he or she, after reaching the age of 11, attended half-time at school and factory until the age of 13. And if it were a question of the withdrawal of the children from school at 11, who otherwise would attend school full time till 13, I should say that the opponents of the system would have a strong case against it. But, unfortunately, as I have already stated on the highest authority, among the schoolmasters, it is the practice throughout the country where no half-time generally prevails, for about two-thirds of the children actually to leave school entirely at the minimum age permitted for half-time factory employment to begin. The great proportion of these boys and girls "finish" their education at 11, and never enter a school again, while the half-timers remain at school for two or three years longer. It is clear, therefore, that at the present time, the factory half-timers, as a class—numbering, in 1895, 55,625 children—obtain considerably more schooling than the large proportion of the non-half-timers, and, as a matter of fact the whole of the half-timers are included in the one-third of the scholars who continue at school after the age of 11.

In the factory districts, as elsewhere, those parents who are really concerned for the educational welfare of their children keep them full-time at school till 13 or 14, although among the children themselves the system is undoubtedly popular, and many well-to-do children are half-timers. The poorest, however, are almost invariably half-timers, and in many cases the one incentive to parental interest in the child's early attendance at school is to insure its passing the standard permitting it to attend the factory and earn wages as a half-timer at 11, and it is but fair to say that from 11 to 13 or 14 no child is more regular at school, because absences must be made up from the factory half-days. The children of the dissolute and drunken parents—the residuum in factory towns—are invariably among the half-timers, and their inferior condition is often represented as the result of the half-time at the factory rather than of the ill-treatment and lack of nourishment at the home. As a matter of fact, but for the factory wages these children would not be at school at all, but drifting many of them into crime and into habits of idleness. I have observed many instances of hardships associated with the half-time system, arising usually from conditions for which the factory is not responsible, but surely full-time at school till 11 for these children and half-time for two or three years after is better than no school at all. The children of the worsted and woollen districts of Yorkshire, where about one-fourth of the factory half-timers of the country are employed, look forward, in most instances, with avidity to their entrance to the factory, and their wages, amounting to from 3s. to 4s. 6d. per week, often form a grateful addition to the income of a family of small children. In my experience of this system I have found that half-timers have taken as good a position in the school examinations as the average children of the same ages in the country generally. I have found also that they have derived industrial advantages and valuable discipline in the factory, and that the association of the factory and the school has not acted injuriously upon them. In my own town a considerable number of the scholarships and exhibitions to the Royal College of Science at South Kensington, and to the Yorkshire College have been taken by students who passed through the half-time schools and who have also been the most zealous and often the most successful students in the evening technical classes. If we turn from the educational to the industrial aspect of this question it must be conceded that in the counties of Lancashire and Yorkshire, where three-fourths of the half-timers are engaged in the cotton and wool industries, their employment exercises an important influence in securing efficiency and economy of production and in supplementing the livelihood of some of the population who would otherwise be among the poorest. It is also a fact, which is worth noting, that among the highest skilled and most intelligent workmen of Lancashire and Yorkshire—the two counties that are at the head of the country in industrial enterprises—the overwhelming proportion began their practical training as factory half-timers. Until the regular attendance at school of all children is secured up to the age of 13, there would be no educational advantage in further limiting the half-time system. But after that time, the educational disadvantage of half-time would be properly dealt with by raising the standard of admission to the factory so that the half-timer's education would not be sacrificed to his labour. We have to consider that the ultimate aim of education is to fit the boy who is born in poverty, for earning his living and for the duties of citizenship. The object of the school is to prepare him for his future work, and it is of the highest advantage that during his school period he should receive some practical industrial training, and for a time after beginning to work, some scholastic and theoretical study. It is the combination of practice with theory, which tends to promote the industrial efficiency of the individual and the prosperity and higher civilisation of the community, and it is in giving a practical and useful illustration of this principle that the argument in favour of half-time labour may be defended. I am of opinion that from an educational as well as an industrial standpoint, it would be an advantage in many instances to the apprentice to extend the half-time system for a year or two longer, so as to secure for him the specific technical instruction that would best aid him in his industrial career.

LEISURE OF ENGLISH OPERATIVES.

Although as I have shown, the overwhelming proportion of children leave school and join the ranks of the workers at an earlier age in the United Kingdom than in some continental countries, there is no country where they have so much leisure after their daily labour. In the textile trades employing young persons and women, the Factory Acts are rigidly enforced, limiting their hours of labour to 56½ per week, while in the great mechanical industries the hours of the adult men and boys above the age of 13 are more generally 54 per week. At from 5 to 5.30, and in fewer instances at 6 p.m., on five days per week, and on Saturdays at from 12 to 1, the workshops and factories are closed. In England the evening classes usually begin at from 7 to 7.30, and on Saturday the half holiday leaves all factory operatives free. In continental countries the operatives in similar industries work 66 or more hours per week, leaving the factories at from 6.30 to 7.30 in the evening, while there is no Saturday half holiday. I have frequently visited evening classes which did not open till 8.30 or 9, in order that apprentices might be able to attend after their work.

My colleagues on the Technical Commission will bear me out when I say that in every department of education in the more advanced continental countries that we visited, we were almost invariably drawn to the conclusion that the buildings, methods, apparatus, and organisation of education were in advance of our own. When, however, we inspected workshops and factories, and learned the conditions of employment, and the wages and hours of work of the artisans, we were equally drawn to the conclusion that in these matters the advantages were on our side. Our industrial life has been founded on workshop practice, and it is in practical skill and efficiency that our workmen have excelled, and have thereby been enabled, in spite of educational deficiencies, to relax the harder conditions of long hours under which their rivals have laboured. Since the time of our inquiry, 1882, I rejoice to be able to state that there has been considerable prosperity among all the nations, accompanied by a marked improvement in the lot of the toilers, but we still retain the lead in the splendid advantage of leisure possessed by our people. But this greater leisure which is enjoyed by British operatives is purchased at a sacrifice of at least a full working day per week, and the wages thereby represented as compared with other nations, and I regret to say that in many thousands of instances the time is absolutely wasted. We can only pay for our immense imports of food and raw materials by exporting the products of our labour and skill to the world's markets where we have to accept as low a price as our competitors who possess a higher educational equipment than ourselves, and whose industrial position is every day growing more formidable. Our extra leisure may confer upon us, as in most instances I believe it does, much compensation renewal in a of force and energy on the part of our workers, but unless it can be used for promoting their higher skill and knowledge so as to improve the quality or lessen the cost of our productions, it may become a penalty that we put upon ourselves for the benefit of our rivals.

GREAT IMPORTANCE OF EVENING SCHOOLS.

In giving our attention to the millions whose education on leaving the day-schools must necessarily be incomplete, the organisation of attractive evening schools in which their education may be appropriately and usefully continued should be our constant care. Experience shows that the better the preparation in the day school the greater will be the demand for, and the more effective the instruction obtained in, the evening school. It is when the boy enters upon his career as a wage earner that he realises the true meaning of education; it is only then that he begins to know what he wants, and the night school only can effectively supply the deficiency. What is absolutely necessary is that every boy in every elementary day school, in addition to drawing and elementary science suited to the needs of the locality, shall go through a course of manual instruction, and the girls through a similar practical course in cookery and domestic economy. Such training will furnish the basis of technical instruction for the artisan population. The establishment of public secondary schools, leading from the elementary to the higher science colleges and universities, cannot much longer be delayed, and these, in conjunction with the secondary, technical, and commercial schools already existing, and equipped, where necessary, with laboratories and appliances for practical instruction, will furnish such theoretical training as will materially help those of higher ability who are preparing for the more important positions in the manufacturing, distributing and commercial branches of business. In fact, the day schools, both elementary and secondary, may be compared to nurseries which prepare students, on becoming apprentices, to take up in the evening classes, and I hope in the same schools, the special subjects of science and art connected with their daily industries. Experience has already amply demonstrated that these young men, with nothing to unlearn, can return from the workshop to their familiar class-rooms, and pursue their technical studies with a measure of enthusiasm and success altogether unknown to students who have not had the same advantages of preliminary training.

It will be understood that, as practical men, we must make the most of the means at our disposal, in many instances limited, and of the material often crude, that we have to deal with. Our organisation must be as elastic as possible, not rigidly enforcing in all instances the prescribed courses. A youth often attends an evening school for specific instruction, and to compel him to go through any special curriculum would frequently drive him away. He had better learn something that has no bearing upon his daily employment than not attend the class at all; and, much as I believe in the instruction that will afford them bread-and-butter, I am at the same time always glad to see our young mechanics give their attention to literature or poetry or music. Indeed, in many instances, they may derive more intellectual benefit and enjoyment from the study of subjects that are remote from practical application than from those which bear more directly on the means of their existence.

Through the powers which are now possessed and are being so rapidly utilised by the public authorities, taken in conjunction with the leisure of our people, the facilities for instruction in evening classes in the United Kingdom will soon be unsurpassed by those of any country. The continuation schools, to which I have alluded, the classes in science and art under the Science and Art Department, the technological classes for every trade that are promoted by the City and Guilds Institute, the university extension lectures, and courses of instruction supplied by the county colleges, such as those of the Victoria University at Manchester, Leeds, and in many other centres, are capable of untold extension and usefulness.

QUALIFICATIONS OF TEACHERS.

In some of the best schools on the Continent the Technical Commissioners found that the teachers were exceptionally conversant with the *practical* applications of the theories which they taught. The English teacher will have to give instruction to apprentices engaged in local industries of which he ought to know more than they, and it is important that he should keep in touch with daily usages adopting workshop terms and methods where he can thereby the better elucidate his subject. Beyond the occasional application of scientific principles to practice there is no great need for the extensive duplicating of the machinery employed by apprentices in their daily labour. In the varied applications of theory to practice in the textile industries a more extensive mechanical equipment may be necessary, but I think that experience shows that upon the whole the evening class should supply the maximum of theory with the minimum of practice rather than the reverse.

VALUE OF SOUND PRINCIPLES.

In art matters also it is more important that the student should be instructed in the principles of art than that his faculty should be immediately applied to industrial purposes. Our practical manufacturers protest that they want designers and not picture painters, forgetting that the power to paint the picture carries with it the power to design, and that to limit the artist in the cultivation of his faculties is to spoil and not to make the designer. I have observed that many manufacturers would have students taught to design textiles before they have learned to draw, or to receive instruction in dyeing before they have mastered the elementary principles of chemistry. There has been this inherent defect—this lack of artistic or scientific basis—in most of our technical instruction hitherto, which has left our students still behind many of their continental rivals. We shall, however, learn by experience that in the long run it is better that a student should be trained in art generally, and allowed to develop his imagination and taste by applying his knowledge to his particular industry, rather than, as is too often the case, he should skip the exercises and become a mere copyist of the designs of others. In visiting the continental schools that had exercised the most marked influence on manufacturing industries, the Technical Commissioners almost invariably found that the true province of the school was never subordinated to the mere teaching of a trade. In pottery, metal work, or textiles, the artistic basis of the instruction was ever kept strictly in view. The director of one of the most famous textile schools said to the Commissioners, "Pray do not call this a weaving school; it is a school of art applied to weaving;" and surely the definition was a proper one. The practice of weaving can best be taught in the factory; but art, or designing, applied to weaving, comes more distinctly within the province of the suitably equipped school with its examples of pure art and its canons of good taste; and what applies to textiles applies to all industries and handicrafts having an artistic basis. In the same way a dyeing or colour-making school would be a school of chemistry applied to dyeing or chemical industries, and the students, trained in principles and in original research rather than in the working out of of recipes dictated by a professor, would ever be ready for dealing with new agencies or inventions.

TRADE TEACHING NOT MOST ESSENTIAL.

I have given some prominence to these elementary truths, because so many members of County Councils and governing bodies, in their enthusiasm for rapid results, would actually make it their object to teach trades in schools, rather than the underlying principles affecting our industries which it should be the aim of the schools to instil into the minds of the students. Besides, it is important that students should have some choice of subjects, so that they may give attention to those for which they may have the greatest natural faculty. To organise the technical instruction of a locality so as to develop its special industries has been found in many instances to be a good thing. On the other hand, to organise the instruction so as to develop the special faculties of the students, has proved to be a still better thing. The former system tends to the concentration of a trade, or a branch of a trade in a given locality, and where there is such concentration there is often exceptional energy thrown into it, but there may also be irregularity and fluctuation in the employment of the people accompanied by alternating periods of inflation and corresponding depression. The latter system tends to the diversifying of the existing manufactures and to the introduction into a locality of new industries, and as it seldom happens that all are unduly busy or depressed at the same time, employment is often more regular and steady. It is idle to suppose that technical schools in small towns do not affect the industrial position of the nation. The fact is that the talent of the nation is so distributed that unless facilities for its development are provided in the smaller places much of it will be lost for ever, but, on the other hand, when once trained it will be available for the world.

FACILITIES MUST BE OFFERED TO ALL.

It has been said by the critics and those candid friends who are ever ready to throw cold water on this movement, that the value of technical education first comes in with those "who emerge from the class of manual workers," the directors of labour, the foremen or those who work more with their brains than with their hands; and that while it may be prudent to spend public money on the training of the talented, it is a waste of money and of effort to attempt any widespread diffusion of technical education among the ordinary workmen. But our critics have never pointed to any method whereby the few may be selected from the mass. The sifting process must begin among the young, and it is not revealed to us when we see the children at the school, or even the apprentices at the workshop, to distinguish those who will be the future brain-workers or foremen. Professor Huxley said it was worth spending a million to discover a Faraday, and so to find the specially capable we must give facilities to all who will come. It must also be noted that it is not usual to find the foreman or even the adult workman in the class-room. By the time that he has risen to a leading position he is no longer a student. In my own experience—going back many years—of the organisation of evening classes in my own town that have been attended by thousands of artisans, I find that in the engineering shops, the building trades, factories, and large industrial establishments, the foremen, draughtsmen, brain-workers and many employers now in middle life began their career as apprentices in the lower ranks of labour. But nearly the whole of these industrial leaders passed through the evening classes of the Keighley Institute 10, 20, or even more years ago, and if the technical classes in those days had only been open to foremen and brain-workers they would have been excluded. The students of to-day are youths and young men, most of whom are probably ordinary apprentices and workmen, but I have not the slightest hesitation in saying that from their ranks the future brain-workers, foremen and employers in their various industries, will rise, and those who may be destined to remain in the rank and file of the industrial army, will be all the better as men for the wider cultivation and refinement which they obtained through their studies and reading.

UNIVERSAL ADOPTION OF TECHNICAL INSTRUCTION ACT.

It seems to me that the great opportunity presented by this Congress, is that it should exert its unique influence in securing for every municipality and local authority throughout the country the advantages which are offered by the adoption of the Technical Instruction and Local Taxation Acts. The ratepayers of the United Kingdom, like their continental neighbours, will thereby be enabled to levy rates for developing the artistic, scientific, and industrial faculties of their young people. After what I have seen in other countries of the wise use and beneficent results of those powers, I am convinced that there is no investment of public money that will so increase the industrial efficiency of the individual, or give so powerful an impetus to the productive agencies and commerce of the nation as the establishment of a sound and appropriate system of technical instruction, in day and evening schools, in every town and village in the country. And in advocating such a movement, I can appeal to those of our guests who have had long experience of its influence in other countries, and who in this, as in other branches of education, have exhibited courage and patriotism far beyond our own in making sacrifices for its advancement. I trust that this Congress will show that whatever may be the rivalries of commerce, we are all at one in our desire for the intellectual improvement of all our peoples, for in the promotion of civilisation, and of the arts of peace, the attendant prosperity and happiness will be shared by all.

Sir **Philip Magnus** said they were very much indebted to Professor Thompson for his paper, if for no other reason, for the argument he had furnished for giving facilities for technical instruction to all workmen throughout the country. With regard to polytechnic institutes, they had heard a great deal about the necessity of co-ordination, and he need scarcely say that where a large number of polytechnic institutes, such as those in London, were coming into existence, some need of co-ordinating the work became necessary. At first they were supported almost entirely by the grants of the Science and Art Department, the fees of the students, and the grants of the City of London Institute, but after the scheme prepared by Mr. Anstie it was thought advisable that a central governing body should take the government into their hands. Later on, a large sum of money came into the hands of the County Council which they were able to use for this purpose, and the main development was, therefore, left to the County Council. But it became very desirable that these bodies, which were providing funds for the institutes, should work in harmony with each other to effect some co-ordination, and that co-ordination was mainly effected by what was known as the London Polytechnic Council. In consequence of the action of this Council much of the co-ordination to which Professor Thompson had referred had actually been carried out. That Council existed for the purpose of preventing the over-lapping o instruction, and it was largely owing to the efforts o the Council that many of the reforms which Professo Thompson suggested had already been carried out, and several of these polytechnic institutes were now giving special advanced instruction peculiar to the district in which they were situated. In a city like London which consisted of over 4,000,000 inhabitants, there was room for a large number of institutions, each of which was doing the same work in connection with a number of different trades. These institutions were situated in localities larger than many provincial towns, but one thing the Polytechnic Council thought most desirable was that the higher teaching which was given in connection with these institutions should be localised, and there should be no attempt made to duplicate it. The consequence was, that whilst one institution had its leather tanning school, another had its cabinet-making school, and another its electrical engineering school, and thus duplication of the work was not permitted. Another object which the London Polytechnic Council had in view, and he believed had been successful in carrying out, was the prevention of what was generally recognised as a great evil—the multiplication of examinations by different bodies. The London Polytechnic Council exercised control over all the polytechnic institutions to that effect, indicating what kind of examinations the several institutions should take; and it had thus succeeded in establishing harmonious relations between the various institutions, which all now worked, not for their own good only, but for the good of the working population of the whole of this vast city.

Mr. **George Howell** said he should like to accentuate what had been so ably said in Professor Silvanus Thompson's paper. He had attended the Conference each day, and he had looked around to see whether he could find any of what were usually called the representatives of industry present. During the three days he had only discovered two besides himself—one a late well-known member of the London School Board, Mr. Lucraft, and the other Mr. King, of the Bookbinders' Society. That did not look very well, so far as appreciation was concerned, of the efforts that were being made to improve workmen in the matter of technical education. Still, there was no doubt we were making great progress in that direction. But he felt that our working men, more particularly, were somewhat afraid that they were making this movement too much a movement for the education of the higher sections of the people, and not so much for the actual artisans. Professor Thompson, in his paper had alluded, among other things, to the division of labour. He should probably startle some of them when he said that no one in the boot and shoe trade alone could make a boot. Not very long ago he asked two experts into how many sections the making of a boot or a shoe was broken up for the purpose of trade. One told him 85 and the other about 120. But, supposing it was only 50, that was something very different from what it was some years ago—say at the commencement of the Queen's reign, when a man had to sit down and make the whole of the boot from beginning to end; or sometimes the uppers were done by one hand and the soles by another. That same process was going on in a variety of industries; and it seemed to him necessary to educate our workmen in the general principles of the trade to be followed, and not only the one particular section at which he might get his living. There technical education would come in and supply the place of what was going out—the old apprenticeship system, to which we could scarcely go back. The building trades were not broken up into so many different elements as boot and shoe making. The bricklayer, the carpenter, and the plasterer each had their own separate work. There was a time when the bricklayer did the plasterer's work, but he must not do it now; the line of demarcation had increased, and if the bricklayer were to do the plasterer's work there would be a strike. There were, however, many things in connection with the bricklayer's trade which it would be well for him to learn; and whilst it might not be very advantageous to teach the bricklayer the chemistry of the colour of bricks, he might be taught another branch of chemistry, which would be of very much greater importance to him, viz., the influence of the acids in the mortar or cement on the bricks. These acids discoloured the bricks, and hence sometimes no sooner was what was designed to be a very beautiful building erected than one saw coruscations of one kind and another all over the work, and that was because the bricklayers did not understand the action of the cement or mortar upon the bricks. Such things as these were elements in technical education which might with advantage be taught to the practical mechanic. What they had to teach him was such things as would enable him to perform his work in the best possible style.

Mr. HOWARD SWAN said he had been occupied for 14 years in what was really a technical institute, founded by Mr. Ruskin, at Sheffield, and he would like to draw their attention to the fact that there existed in Sheffield a unique technical institute, in which were specimens of the highest technical examples of sculpture, wood-carving, water and oil-colour painting, ceramic work, and also poetry and literature. However well the plumbing and bricklaying might be done, we should still strive to have more beautiful architecture for our buildings, and when we had the buildings we wanted beautiful ornaments to put in them, and then we must have beautiful men and women to occupy the buildings. Mr. Ruskin's great aim in starting this technical institute was to prove that it was possible to become an artist in human clay. As a result of the influence and training received at Sheffield the speaker mentioned the work of a Sheffield grinder, who, though hardly able to write or read, had a certain faculty for manipulating pieces of clay, and had turned out some extremely interesting clay work. Under the influence of Mr. Ruskin and his (the speaker's) father, this man had developed into an extremely clever sculptor; he had exhibited his work at the Academy, and had become the principal of the School of Sculpture at Birmingham. Another instance was that of a young cabinet maker who, under the influence of the pictures Mr. Ruskin had presented to the Sheffield Institute, became a water-colour artist. In concluding his remarks, Mr. Swan said he felt convinced that you could make literature a technical subject, and that people could be trained to write good essays, good reports, and even good text-books. Those who were teachers would know what that meant. The influence and training of such institutes as that at Sheffield would enable them to reach the highest point to which they could go in technical education.

Professor J. VIRIAMU JONES, F.R.S., remarked that he was a little surprised to hear Mr. George Howell speak as if the Conference devoted itself too much to the consideration of higher technical instruction and too little to the consideration of the instruction of the artisan. Personally, he thought they had heard too little about the higher technical instruction in the provinces. The higher technical instruction in our great provincial towns was given by the university colleges. He referred to that because Professor Thompson, in his admirable paper, seemed somewhat to discount university influence in technical education. He (the speaker) thought it would be a great mistake if we committed ourselves to a set of technical institutions disconnected from the universities. From the earliest dawn of education in Europe, universities had been technical institutions. The original faculties were those of medicine and civil law. But why should higher instruction in engineering be regarded as more outside the province than instruction in medicine, or instruction in the profession of law. University colleges had already shown what they were capable of doing in respect of technical instruction. The problem of dealing with this question was more difficult in London, owing to the vast population, than it was in a provincial town; but matters in London were enormously complicated by the fact that we had not a teaching university. He was glad to have had the opportunity of referring to the technical work of the university colleges, because he looked forward to the day when an enlightened Chancellor of the Exchequer would see the possibilities in connection with such institutions. If a system of higher technical instruction was to be developed throughout England it could most easily be done in connection with those institutions. When he heard of the large sums of money which were being spent on the Continent, and the magnicent development of their technical institutions, he could not help hoping that before very long we should see our university colleges released from their financial difficulties, and able to do what he was sure they could do—develop a system of higher technical education quite comparable with that which existed in Germany and other countries on the Continent. He sincerely hoped that we should see before very long a great teaching university in London, which would be able to do for this vast population what he looked forward to the university colleges doing for technical education in the towns in which they were placed.

Mr. Sidney Wells said he wished to say a few words on one or two points arising out of Professor Thompson's paper. On the principle that a little practical experience in these matters spoke quite as much as a great deal of theory, perhaps what he was about to say would carry as much weight with the Conference as the opinion of so distinguished an educationalist as Professor Thompson. Professor Thompson in his paper seemed rather to deprecate the teaching of chemistry to chemical workers. In Battersea there was a very large chemical industry, and, during the past year, the employers of one of those large factories—Price's candle factory—had paid the class fees of a number of their ordinary apprentices—not their skilled chemists—in order that they might attend the evening chemistry classes at the Battersea Polytechnic. When they saw a firm, whom they might suppose understood the value of that kind of thing commercially, doing that, and when they saw the lads willing to attend the classes after working all day in the factory, he thought it said something for the need which not only the employers but also the employees felt for technical education. Polytechnics, at the present time, were trying to give that training which the sub-division of labour made it so impossible for a mechanic to obtain. If an engineering student attended their workshop at Battersea, and they found he was only allowed to work at the lathe all day, they allowed him to work at other machines in order that they might make a more complete and thorough workman of him. Another point was the absolute necessity for polytechnics to do some special work, and the danger of their all trying to do everything. But they must remember that the London polytechnics were not like similar institutes in provincial towns. At Battersea there was a population of a hundred thousand people, mostly belonging to the artisan classes, living within a square mile of the Polytechnic. They could afford to teach many subjects without fear of their overlapping other institutes two or three miles away. It was quite unreasonable to expect a student living in Battersea, Tooting, or Balham to journey three or four miles to get his education after he had done a hard day's work. His last point was that Professor Thompson hoped the London polytechnics would not try to train their students for university examinations. He (the speaker) hoped that the polytechnic authorities would not be led away by the glamour of higher university teaching. They would continue to believe that they were doing a great and much-needed work if they reached the artisan classes. But what about the elementary school teacher? What about similar young men of his class, who were working all day for their living, and could only attend evening classes, and yet still wanted to obtain a university degree! The higher colleges in London were not open for the reception of such students, and if they were it was unreasonable to expect that an elementary school teacher, living at Tooting, was going to journey to Kensington every day for his classes; and, they did feel they were doing a good and a right work in endeavouring to meet the needs of these young men and women who had to work all day to earn their living by providing evening classes that would enable them to take university degrees, and thereby help them in the work of life.

Professor Bodington thought university teaching and the higher technical teaching should not be disjoined; the training of the artisan should not be separated from the man of science. He thought our university colleges should be opened to the artisan with the same freedom as the polytechnics. He should like to see scholarships offered in connection with the university college and higher places of education so as to make it possible for all to take advantage of them in some way as the German universities could be taken advantage of. That was a long way off at present. Meanwhile, the university colleges were struggling with financial difficulties—difficulties which he knew the Chancellor of the Exchequer was approaching in a very small and inadequate way, but at the same time they were grateful for the recognition they had had.

Dr. R. M. Walmsley understood that the chief object of a technical institute was to broaden the views and capabilities of the workers. Everyone knew that under the present system of subdivision of labour a sudden change of fashion might throw whole establishments of workmen out of work and on to the parish if they could only perform the one branch of work with which they had been connected all their lives. One of the main objects of the technical institute was to train workers in the cognate branches of their trade, so that when a change took place they might be able to take up another branch, and so be able to continue to earn their bread. He was glad to be able to inform Professor Sylvanus Thompson that in the Northampton Institute chasers were learning engraving and engravers were learning chasing; and throughout all the classes they proposed to make the student acquainted with more than one branch of his trade.

Mr. Edric Bayley said he attended the Congress principally to ask two questions. The first was: how can we get employers to take more interest in their work-people? and, secondly, what can we do for women's labour. With regard to the first point, Mr. Wells had told them of a firm at Battersea who paid the fees for some of their apprentices to attend chemistry classes. There was one trade in London, and he believed the only one, viz., the printers' trade, many of whom gave their apprentices an hour off to enable them to attend evening classes, and also paid their fees. Employers in the North of England were more public spirited. He wanted to know whether this Conference could help in any way to induce employers to take more interest in their apprentices. Coming to his second point, he said women's labour was in such a disorganised state that it was difficult to do anything effectively. They had tried to start classes in book-binding and upholstery for women, but they failed to get anyone to attend. He believed the reasons were the long hours, bad wages, and the bad conditions under which they had to work. Until they could get women to form trades unions, so as to secure for them shorter hours, better wages, and better conditions, they would never be able to make technical education of much use to them.

The CHAIRMAN said owing to the lateness of the hour it would be impossible for him to in any way sum up the results of all that had been said. They had had a most interesting discussion. It had wandered from the very lowest branch of technical education up to the highest instruction given in the universities. Undoubtedly, one of the problems of the future was how to weld together and make part of one system the whole of the teaching which was given in connection with technical training. He thought they would have to realise that the training of the higher leaders of industry, the skilled directors of others, stood on a different footing from that of the humble worker, who carried out only what he was told to do. He did not think Professor Thompson would wish to discourage the increase of intelligence or the increase of curiosity with regard to the work of the artisan. They wanted him to take the greatest possible interest in his work, to understand at what he was driving, and, as far as possible, to reason upon every process of which his own was only one of the smaller parts. What was the character of good artisan education, how far it should be specialised, was not a subject of unanimous agreement. . One of the advantages of such a Conference as the present was that these difficulties, and the objects at which the leaders of industry and the leaders of technical education were aiming, were brought before a very wide and varied body, and he could not help believing that before we arrived at any definitely recognised system in the various branches of technical education, a very large number of experiments would be necessary—experiments some made in provinces and some in London—but when the result of those experiments had been gained, he thought they would be able to say that the burst of educational enthusiasm which the latter part of the reign of the Queen h seen in England, had had its effects not only upon the education of our workpeople, but upon the commercial and manufacturing predominence of England itself.

Miscellaneous.

VILLAGE INDUSTRIES OF RUSSIA.

The most noticeable feature of Russia, as distinguished from Western European industry, is the more intimate connection of the former with rural economy. This means that to this day, at any rate in the majority of cases, the Russian factory hand does not abandon husbandry in his own village, but strives to maintain his connection with the land, and that trades in Russia are developed to a far greater extent in the villages, than in the towns. According to a report issued from the Chancery of the Committee of Ministers, St. Petersburg, in ancient Russia the town still retained comparatively more importance for industry. In the Moscow period, however, with the strength of the power of the Government, and the decline of the autonomy of the towns, trades began to be concentrated in the villages, whence craftsmen began to visit the towns only for temporary engagements on hire, or to execute the Tsar's tasks as a duty. The causes of the concentration of handicrafts in the villages were many. Town life was very feebly developed, the towns themselves differed little from villages, and in the village, husbandry alone did not always and everywhere afford a living to the peasantry, as is the case also at the present time. On the other hand, the prolonged winters, especially in Central and Northern Russia, left a great deal of spare time. In this village industry, or, as it is called, "Koostar" industry, besides the head of the family, the other members, both men and women, take part in the work, and, not unfrequently, children of seven to ten years of age. In some trades, particularly in those of lace-making and weaving, women even take the chief part. Village industries, in the course of their long history, have elaborated peculiar technical methods of their own, and a certain division of labour. Thus, for example, one part of the work is performed by children, another by adults, and a third by the aged; or in one village, one part of the article is made, in another neighbouring village, another part, while in a third, the parts are put together, and in a fourth, painted. Under these conditions, koostar industry has continued to develop, notwithstanding even that the cheapness of peasant labour, and of materials, and the immense competition resulting from these causes, and the difficulty of sale, have considerably reduced the prices for these goods. There are now in all over 50 distinct kinds of village or koostar trades. Without dwelling upon their description, it will be only necessary to say that, in accordance with local conditions, the village artisans or koostars are employed above all in the manufacture of articles from wood. There are as many as 80,000 households employed in making baskets, mats, wheels, carts, buttons, spoons, and even furniture and concertinas. The northern flax-growing districts manufacture linen, tablecloths, and towels. The central districts take orders from the manufacturers for weaving the commoner cotton goods. More than 150,000 men are occupied in the preparation of leather. As many as 19,000 peasant households are employed in the manufacture of hardware. Particularly well-known in the last respect are the villages of Pavlovo, Vorsma, and Bezvodnoe, in the government of Nijni-Novgorod. Together with the extensive koostar districts adjoining them, these villages earn very considerable sums each year, and Pavlovo has, on account of the excellent workmanship of its cutlery, gained the name of the Russian Sheffield. If to the above-mentioned industries be added the "samovar" industry in the Toola Government, the painting of images on wood, lace making, and the manufacture of toys, this will complete the enumeration of the principal branches of koostar production. It is impossible to arrive at the total value of the production of such goods in Russia, from the absence of any reliable data. An equal uncertainty exists as to the exact number of persons employed in koostar industries. Some investigators fix it at 6,000,000, or four times that of the factory hands and miners. In any case, even these approximate figures are a clear indication of the importance of koostar in Russia. In some branches of industry, it stands higher, in regard to the value of the output, than that of the factories. For example, in the leather trade, the production of the manufactories is estimated at from £3,700,000 to £4,200,000, while that of the koostars reaches £5,800,000. The question as to whether koostar industry in Russia is doomed to be absorbed by manufacturing industry on a large scale, is a moot one. In that country the solution of this question depends not only upon the advantages of production on a large scale over small production, in the sense of the application of improved methods, cheapening the work of machinery, &c., but also upon the need of the koostar for agricultural earnings; for so long as these earnings possess for the peasant sufficient importance for him to regard the koostar industry as a supplementary one, so long will he be in a position to reduce the price of the articles he makes almost to that of the material, and not to aspire to such a wage as would secure his independent existence. Taking, however, everything into consideration, the Russian koostar industry is stated to possess many elements for a prolonged existence and for considerable development. The most important measure for the improvement of koostar productions, and of the economic condition of the koostars themselves, must be regarded as the extension among them of technical knowledge, of credit, and of stores for the sale of koostar goods in the great towns, &c. These questions have lately been receiving the most careful attention from the Government and the rural authorities (Zemstvos). There is a remarkable collection of the products of koostar industry in the St. Petersburg Agricultural Museum, and koostar exhibitions are organised in other parts of Russia.

General Notes.

CARBIDE OF CALCIUM.—In view of the growing importance of the manufacture and the use of carbide of calcium for illuminating purposes, it was considered desirable by the State authorities to promulgate certain regulations with regard to its sale and storage which were formally specified in an Order in Council dated February of this year. The regulations appear to be founded largely upon the Petroleum Acts, 1871 and 1881, but as the regulations referred to in this connection might be considered as not sufficiently explicit without further definition, the Acetylene Illuminating Company, manufacturers of carbide of calcium at the Falls of Foyers, have issued a pamphlet containing an abstract of both the Petroleum Acts and the regulations of the London County Council applicable to the storage of carbide of calcium. It is pointed out in the preliminary observations made by the Acetylene Illuminating Company that it is optional for all Local Authorities to modify the suggestions made by the London County Council in any manner they may think desirable. The Acetylene Illuminating Company states that the Home-office are anxious to avoid any measures which might result in an obstruction to the new industry, at the same time entertaining a careful and proper regard for the public safety.

LAND TENURE IN JAPAN.—Under existing treaties, foreigners are not permitted to hold land in the Empire of Japan in fee, or by what is known as "lease in perpetuity" outside the foreign concessions. Land suitable for large factory sites is not obtainable in the foreign concession at Hiogo (Kobé), but were it otherwise, the prevailing price at which it is held is such as to render it undesirable and unprofitable for factory purposes. According to Consul Connelly, under the provisions of an arrangement concluded at Kioto, on March 26th, 1868, between the Japanese Government and the representatives of France, England, and Holland, foreigners are permitted to lease lands for a term of years, not exceeding twenty-five, in certain described limits outside the foreign concession at Hiogo. All improvements on such leased lands, in the shape of buildings, fences, &c., if not removed prior to the expiration of the lease, revert to the owner or owners. Foreigners occupying land outside the foreign concession at Hiogo (Kobé), and within the limits set forth in the arrangement of March, 1868, referred to above, are obliged to pay such taxes as may be levied upon their possessions for municipal and Government purposes, in the same manner as such taxes are paid by Japanese subjects.

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International Congress on Technical Education.

THURSDAY AFTERNOON, 17TH JUNE.

SECTION A.—*(continued).*

WILLIAM WOODALL, M.P., in the chair, followed by Lord BELHAVEN and STENTON.

THE DEVELOPMENT OF TECHNICAL INSTRUCTION IN SECONDARY SCHOOLS UNDER THE PROVISIONS OF THE TECHNICAL INSTRUCTION ACTS, 1889 AND 1891, AND THE LOCAL TAXATION ACT, 1890.

By H. MACAN, M.A.

(Organising Secretary to the Surrey County Council, Hon. Sec. to the Association of Organising Secretaries.)

My object in presenting to the International Congress this survey of the progress made luring a period of about five years in one portion of the educational field, is not so much o show the great change in curricula, and he alteration in aim of the teachers, which has affected those who were expected (and most of whom hoped) to be impervious to such nfluences, but rather, on the eve of a great administrative change, to point out to the nterested politician what influences have been at work in shaping those ends rough-hewn by his legislative machine.

To persons acquainted with English methods of progress, and more particularly with the absolute indifference to education which is characteristic of the masses of the people in his country, it will not be a matter of surprise f I say at the outset that this paper deals with an important educational development never contemplated by the Acts of Parliament under whose cover it was carried out.

The agitation which was carried on throughout the country in the three years preceding 889 on behalf of a Technical Education Bill, and in which the present Duke of Devonshire, Sir Henry Roscoe, Sir P. Magnus, Mr. A. H. D. Acland, and Mr. Llewellyn Smith were the eading figures, was certainly understood by the public at large to aim almost entirely at providing manual instruction in connection with our elementary school system, and some specialised technological instruction chiefly by means of evening classes for persons who had passed the school age. In fact the situation as then understood may be summed up in the words of the second report of the National Association of Dean's-yard expressing regret that "no progress seems to be possible towards solving the question of the provision of technical instruction for the children of the working-classes *in elementary schools*;" and in the resolution of the Head Masters' Conference, 1888, that "the true solution of the problem of higher technical and commercial education is to be found in continued study of a specific kind on the part of those who have left school."

To what, then, are we to attribute the fact that the powers under the Technical Instruction and Local Taxation Acts are at present being used very largely for the improvement of scientific and commercial education in *secondary day schools?*

In the first place, no doubt largely to the action of the National Association in including in its programme (though it was not in the forefront) "the development, organisation, and maintenance of a system of secondary education throughout the country, with a view to placing the higher technical and commercial education in our schools and colleges on a better footing." Perhaps a more important factor still was the passing of the Welsh Intermediate Education Act in the same year as the Technical Instruction Act. This gave to Wales the full powers still denied to England, and the vigorous way in which it was put in operation directed the attention of thoughtful men to its provisions, and made them desirous to emulate its results in this country, even with the imperfect machinery at our command.

The circumstances under which Sir W. Hart-Dyke's Technical Instruction Act itself was passed contributed to the same end. Finding it impossible, for reasons which have been fully apparent in the present Session of Parliament, to attempt to deal with the whole question, he decided to drop all reference to technical instruction in *elementary* schools from his Bill, and even to deprive scholars in the standards of all its advantages. At the same time, by constituting (as a natural corollary) other (*i.e.*, non-elementary) bodies, namely, the municipal councils of counties, boroughs, and urban districts, the authorities under the Act, rather than school boards and school managers, a class of persons was imported into the educational field whose instincts and experience lay rather in the development of secondary than of elementary technical education.

But the most potent influence of all in diverting the purposes of the Act was the change which was coming over the spirit, the aims, and the work of the Science and Art Department.

This body, to whose work as the pioneer of technical education I desire to bear testimony, was formed originally for purely industrial purposes, and for "extending knowledge of design (afterwards of science also) among the manufacturing population of the country." It naturally proceeded at first by means of evening classes for adults and semi-adults; but these classes became gradually used by *younger persons*, and, as a result of the Education Act, 1870, School Boards developed an ambition (highly laudable in the absence of legitimate machinery) to connect the work of their upper standards with the work of the Department. Thus came *day* classes. Special schemes for instruction in these were promulgated in 1872; thence arose the Organised Science School, a great advance—and its successor of to-day, the "School of Science." (What is really meant by this misleading title is the science side or section of a general secondary school.) This new development made little progress until 1883, when there were only five of these schools presenting for examination 256 students. At the present time there are in the United Kingdom 156 of them with 18,560 day students. The most rapid increase has taken place since the beginning of 1895, when Mr. Acland's celebrated new rules (Form No. 201) came into force. By these, result grants were largely replaced by liberal inspection grants, and literary instruction, "Essential for a good general education." found its place in the official time-table; at the same time, by a curious coincidence, the limit of income of the grant-earning classes was by the new Income Tax Act raised to £500 a year. The anticipation of the late Royal Commission that the increase would be by "leaps and bounds," has been fully verified, for while in 1892-3, the total Organised Science Schools (in England alone) was 64, and in the year the Commission reported 98, it has now reached the number of 137.

The total grants earned by the schools under the Department in 1894-5 was £143,000 a year; it has now reached nearly £253,000. A the Royal Commission put it, "In respect o these grants, though they were not originall made to schools, or even to education give in schools, yet the tendency in our legislativ and general changes in education has been t render them grants to scholars in schools.' And again, "This sum (spent by the Department) virtually goes in aid of secondary education, and a large part of it is spent in da schools."

Thus, by a natural evolution, the industria Department for the continuative evening education of the labouring classes became one o our central authorities for aiding the secondar education of the middle classes.

When, in 1890, the County Councils first cam upon the scene, and were presented with (i England alone) over £700,000, which the might devote to technical education, it is not t be wondered at that the attention of many o them was drawn at once to the operations of th Science and Art Department.

They were inclined to regard the work o that Deparment from three points of view :—

1. As a terrible example of what to avoid
2. As something entirely good in th *original* conception of its object, namel —as a means of elevating the workin man.
3. As a study in development, teachin County Councils to begin where it ha ended, and continue what it had begun

I may dismiss from consideration the firs point of view, which merely arose from a mistaken regard to excrescences upon the Department, rather than to its essential position an work, and which is now, thanks largely to th efforts of Captain Abney and the exper inspectors appointed by Mr. Acland, seriousl held by nobody except a few schoolmaster whose schools have received bad reports an low grants. The crudeness of the old scienc syllabuses; the evil effects of payments upo purely elementary results; the concentration o inspection in the hands of retired militar persons, lacking alike in knowledge an suavity; and the predominance of (farmed classes under the control of teachers wit minimum qualifications, have all now passe away, and there is no longer any excuse fo any local authority adopting an attitude o hostility to the Department in the developmen of its technical instruction scheme.

Theory No. 2, the old days of the Department, or the "working man" theory of tech nical education may be contrasted with No. 3, the new Departmental, or "talent catching" theory; it is the conflict between these two which explains the diversity of practice between various counties with which I propose to deal, and which more than anything else calls aloud for legislation.

It must be premised that there is nothing incompatible between the two points of view as regards the administration of the technical instruction funds. It is quite possible, as has been shown in all the most enlightened counties, to devote a sum equivalent to a ¾d. rate to continuation school and evening class education, and a sum equal to ½d. rate to technical secondary education; the former touches those classes generally, which work mainly with their hands in the day time after 13 years of age; the latter interests the middle classes, whose children remain at school until at least 16 or 17 years old, but also leads into the higher sphere the more capable children of the former class. I do not propose to discuss the limits, legal or otherwise, placed upon the operation of County Councils by the Acts, as this will be dealt with fully by my friend Mr. Turner. I will only say that every subject taught in a secondary school, except Latin, Greek, and English Literature, has been sanctioned by the Department as a fit subject to receive aid from County Council funds, and that there is not one word in the Acts limiting their provisions to classes of an elementary kind, to the instruction of any social grade of the community, or to persons with any limit of income.

However, in many parts of England still, no aid is given to secondary day schools towards providing technical instruction, and no scholarships are available, specially tenable at such schools; this fact explains what must be otherwise inexplicable to the stranger, namely the different attitude towards the technical educational movement, and towards the local authorities, and the differences in the very conception of the meaning of "technical" which is taken by head masters and other high educational authorities in various parts of England.

Three important pronouncements have been made at various times directing the attention of County Councils to this particular aspect of the subject and to the claims of secondary schools upon them.

The first is contained in the 38th report of the Charity Commission, dated 21st of February, 1891, and is as follows:—

"The provision made by the Local Taxation (Customs and Excise) Act, 1890, for the distribution to County Councils of certain funds dealt with by that Act, with power to contribute the same for the purposes of technical education within the meaning of the Technical Instruction Act, 1889, has an important bearing upon our work under the Endowed Schools Acts. It has recently been announced that this provision, or its equivalent, if utilised for educational purposes, may not improbably be rendered permanent. In view of the magnitude of the funds thus made available for educational purposes, and to the degree in which secondary education, both technical and general, has been provided in schools which are within our jurisdiction, the proposed appropriation of these funds, whether in aiding existing institutions or in founding new ones, must materially affect the fortunes of these schools, and the character of the education to be given in them. Technical instruction, as defined in the Act, means instruction in the principles of science and art applicable to industries, and in the application of special branches of science and art to specific industries or employments. It is true that this definition is extended so as to include a large part of what is usually considered to be secondary instruction in its general sense, such as, among other things, the teaching of modern languages; but in the intention of the Act, and as a starting point for its administration, the application of these funds is thus limited to a section only of the field of secondary education, and to secondary education regarded in a particular aspect.

"There is, however, evidence that a desire exists to take a wider view of the subject, and to give assistance to secondary education as a whole. In Wales, where two alternatives were given—that is to say, to appropriate this fund either in aid of secondary education generally under the Welsh Intermediate Education Act, 1889, or under the Technical Instruction Act, 1890—it is the first, and not the second, alternative that appears to be the more favoured hitherto. Even in England we have received proposals, in more than one instance, from County Councils, for the reorganisation of particular endowments within our jurisdiction, in connection with grants to be made from this fund, where the institution to be aided is not exclusively employed in giving technical instruction, and is not intended so to be. Under these circumstances it appears desirable that, in any future appropriation by Parliament of equivalent funds in England, the limits of appropriation should be defined so as to cover the whole field of secondary instruction suitable to the class intended for benefit, and not merely that of technical or manual instruction, however widely the term may be extended by definition."

As a first result of this advice, we find in the next report (Feb. 23, 1892) the following reference:—

> "We have readily entered into a large project promoted by the County Councils of Kent and Surrey for the establishment of a fully-equipped College and School of Agriculture."

And

> "Apart from the project above referred to, the County Council of Surrey have determined to aid the endowments of several grammar schools within their area by yearly grants varying from £150 to £250 a year, conditionally upon the due representation of the Council upon each governing body. A draft scheme is now in progress providing for the required enlargement of the several governing bodies and otherwise adapting the schools aided to the requirements of the Council in respect of the provision for scientific and technical instruction."

(Opposed as I am to any mention or exaltation of one's own county so common in papers and speeches in this connection, I may perhaps be pardoned for this one instance, as there happens to be no other available.)

The second typical allusion by an outside authority to this branch of County Council work was in the Report of the Royal Commission on Secondary Education, dated August 13th, 1895, where it is pointed out that

> "Without infringing the provisions of the Technical Industrial Acts, a large proportion of the county funds are already being spent directly or indirectly in the maintenance and improvement of Secondary Schools,"

And

> "County Councils have generally found it unwise, if not impossible, in dealing with children of school age, to treat technical instruction as a thing separate from general secondary education,"

And again,

> "An immense impulse has been given to technical education (under the Local Taxation Act), and as that term has been extended to cover the whole field of mathematical and physical science, as well as modern languages and some departments of geography, while grants have frequently been made to schools giving a general liberal education, the impulse has been felt in many branches of secondary instruction."

Finally we have, as the matured judgment of experts upon the real question at the bottom of all technical education in any country, *i.e.*, how far it is being kept abreast of what is going on elsewhere, the report in December, 1896, of the visit of Sir P. Magnus and his colleagues to Germany. A few extracts from this will suffice:—

> (*a*). "Much more is being done for the training of those destined for the *higher* ranks of industry in Germany than in England."
>
> (*b*). "Our recent visit has also impressed us with a sense of the advantages which the nation (Germany) derives from having an organised system of secondary education."

But on the other hand

> (*c*). "We have no reason to think that better facilities for technical and scientific teaching are offered to foreign *workmen* than those within the reach of our own industrial population."

These three sets of opinions just quoted appeared in the beginning, at the middle and the end of the purely technical legislation movement, and are intended to show how little excuse there can be for those who still consider that the "working man" theory covers the whole ground, or that it is any longer possible to resist the lesson drawn earlier from the development of the Department of Science and Art that technical instruction cannot and must not be organised apart from secondary education.

In the first two years of the operations under the Local Taxation Act, direct aid to technical instruction in secondary schools was given by the following counties and county boroughs:—Reading (*b*), Cumberland, Derbyshire, Devonshire, Durham, Essex, Gloucestershire, Bristol (*b*), Herefordshire, Hertfordshire, Canterbury (*b*), Burnley (*b*), Bury (*b*), Liverpool (*b*), Manchester (*b*), Leicestershire, Lincolnshire (Lindsey), Norfolk, Northamptonshire, Oxfordshire, Peterborough (Soke of), Somerset, Southampton (*b*), Staffordshire, Wolverhampton (*b*), Surrey, Sussex (East and West), Yorkshire (East Riding), Hull (*b*), Yorkshire (North Riding), Yorkshire (West Riding), Middlesborough (*b*), Bradford (*b*), Huddersfield (*b*), Sheffield (*b*).

In the following year (1892-93) the above-named authorities were joined by Bedfordshire, Cambridgeshire Cheshire, Lincolnshire (Kesteven), and Northumberland.

In the year 1893-94 to these were added the following:—Berkshire, Nottinghamshire, Shropshire, Ipswich (*b*), Westmoreland, and Wiltshire.

In the year 1894-95 Dorsetshire, Isle of Ely, Huntingdonshire, Kent, Lincolnshire (Holland), London, Middlesex, Northampton (*b*), Newcastle (*b*), Hampshire, and Warwickshire, made direct grants; but a few others fell away.

Among the minor authorities (non-county boroughs, &c.) Banbury, Northwich, Dewsbury, Doncaster, and Wakefield have at one time or another given similar assistance.

No addition in 1896 has been made to the ranks of the authorities named above, but two have fallen away. At present no direct aid to secondary schools is given by the following :—

Counties (9).

Buckinghamshire,* Cumberland, Cornwall, Lancashire, Rutland, Suffolk (East and West), Isle of Wight, Worcestershire.

County Boroughs (44).

Birkenhead, Chester,* Stockport, Derby, Devonport, Exeter, Plymouth,* Gateshead, South Shields, Sunderland, West Ham, Gloucester, Canterbury, Barrow, Blackburn, Bolton, Bootle, Barry, Oldham, Preston, Rochdale, Salford, Wigan, Leicester, Grimsby, Lincoln, Norwich, Nottingham, Oxford,* Bath, Portsmouth, Henley, Walsall,* West Bromwich, Wolverhampton, Croydon, Birmingham, Coventry, Dudley, Worcester, Middlesborough, Halifax, Leeds, York.

Thus of the 49 counties 9 alone give no direct aid to secondary schools. Of the county boroughs 44 give no aid. While of the subordinate rating authorities (214 boroughs and 728 urban districts), 180 of which raise a rate and 200 have grants to expend practically at their discretion, only five directly aid secondary schools in their districts.

It is not within the scope of this paper to draw an obvious moral.

As a summary of progress the figures of the total grants made may be set out thus :—

Grants given by County and County Borough Authorities in England to Endowed Grammar and other Secondary Schools during the years 1890–96.

		Authorities
2 Years 1890–91 1891–92	£23,581 to *all* secondary schools, ……….by	36
Year 1892–93 ..	£22,031 to all ditto, ..by	41
Year 1893–94 ..	£15,323 to *endowed* schools, + (about) £7,000 to organised science schools, by	47
Year 1894–95 ..	£32,521 to endowed schools, + (nearly) £10,000 to organised science schools, by	54
Year 1895–96 ..	£45,000 (about) to all schools,…………..by	60

NOTES.

It is important to notice that while the above figures, as far as taken from the Return of the Department, relating to the *years* 1893-4 *and* 1894-5 *include* only the grants made to *endowed schools*, which are governed by schemes established under the Endowed Schools Acts, the *figures relating to the previous years include grants* made to *all types of secondary* schools (endowed, organised science, and otherwise). This will therefore explain the apparent decrease in the total sum spent on these schools during the year 1893-4. The figures *are not given separately* in the two first Returns.

The figures relating to organised science schools and the figures for 1895-96 are calculated from unofficial sources.

The most liberal aid is given by the following counties :—Derbyshire, Devonshire, Dorsetshire, Durham, Hertfordshire, Kent, Lincoln (Lindsey), Somerset, Hampshire, Surrey, and Yorks (East and West Riding).

Great advances in this direction have recently been made by Middlesex, Herefordshire, and Shropshire.

The nature of the assistance may be briefly stated as follows :—

(*a*). Providing teachers of science.
(*b*). Fitting laboratories or providing apparatus.
(*c*). Fitting workshops or paying manual teachers.
(*d*). Providing art teachers.
(*e*). Providing modern language teachers or aiding shorthand instruction.
(*f*). Building or rebuilding schools, wholly or partly.

(*a*) and (*b*) absorbs about two-thirds of the whole money; while in certain counties just starting this work (*f*), and to some extent (*c*) for a few years appear as the principal items.

For instance, the London County Council spent :—

	1893-4	1894-5	1895-6	1896-7
	£	£	£	£
In Maintenance…	7,105	6,340	7,712	9,135
In Equipment……	5,110	4,030	1,945	4,685
Total………	12,215	10,370	9,657	13,820

Of the total sum of £13,820 spent in 1896-97, and given to 45 schools, in 16 cases better provision for science teaching was the object of the grant.

Again, Hampshire, which has just started its secondary work, in its last report allocates £3,000 to three schools for building purposes.

I now give five specimen programmes that show the nature of the work in counties in different stages of development :—

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* Capitation grants offered.

* These have organised some day technical schools of their own.

KENT (97-98).

I.—*Capital Expenditure (paid or promised) for new Science Buildings and Equipment.*

Faversham, Boys	£323 paid
,, Girls	£390 (£300 paid)
Maidstone, Boys	£188 paid
,, Girls	£250 ,,
Rochester, Boys	£340 ,,
,, Girls	£170 (£120 paid)
Sandwich	£400 (£325 ,,)
Sevenoaks	£300 promised
Yalding	£50 ,,
Canterbury, Boys	£80 ,,
Total	£2,491

II.—*Annual Grants towards salaries of Science Teachers.*

£100 a year.	£50 a year.
Borden.	Ashford.
Folkestone.	Canterbury, Boys.
Maidstone, Boys	,, Girls.
,, Girls	Dartford.
Rochester, Boys	Sevenoaks.
,, Girls	Yalding.

£75 a year.
Sandwich.

SURREY (97-98).

SCHOOLS.	Science.	Special.	Short-hand.	Total Surrey Payments.
	£	£	£	£
Dorking, High	200	—	20	220
Farnham Grammar	250	160	20	430
Guildford Grammar.	250	—	20	270
Merton Rutlish	250	180 (Art)	20	450
Kingston Grammar	88	12* (Middlesex)	—	88
,, Tiffin's Boys'	170	82* (Middlesex)	20	190
,, ,, Girls'	121	29 ?	—	150
Reigate Grammar	250	—	20	270
Richmond County	250	180 (Art)	20	450
Wallington County Girls	100	—	—	100
South Wimbledon Girls	100	100	—	200
			Total	£2,818

* To be paid by the County Council of Middlesex.

Part services (given to each school) of two travelling modern language teachers=£600.

CONDITIONS.—Time table to be approved; the school to be open to inspection of Council; two to four representatives to be appointed on the governing body by an amended scheme of the Charity Commissioners.

The Technical Education Committee of this Council have spent (since 1892), or are engaged in spending, £22,000 in building grants for secondary schools and schools of science and art, and technical institutes, in the chief towns in the county where none existed before. In addition to the above, a sum of nearly £15,000 has been contributed from local sources to these purposes.

Large additions (laboratories, &c.) have been made to all endowed schools, and Reigate and Farnham schools have been partly rebuilt. The new buildings at Richmond, Wimbledon, Wallington, and Sutton are for use as secondary day schools.

ESSEX.

The aid given to secondary schools has taken the form of grants towards the cost of additional science masters, and for providing chemical laboratories, fittings and apparatus, as the circumstances of the school required.

The schools aided during the year and the general conditions on which the grants are made are as follows:—

School.	GRANT.	
	To provide additional Science Master.	Towards the erection and fitting up of Laboratories or Workshops
	£	£
Chelmsford Grammar School	120	—
Earls Colne Grammar School	75	50
Halstead Grammar School	100	—
Sir George Monoux' School, Walthamstow	100	—
Palmer's Endowed School, Grays	100	25
Saffron Walden Grammar School	125	—
Total	620	75

A most interesting printed statement setting out full particulars of all the endowed schools in the county has been prepared, but is too long for publication here.

DORSET.

School.	Building and Equipment Grants.	Annual Teaching Grants.	Total.
	£	£	£
Beaminster Grammer School	250	—	250
Foster's School, Sherborne	200	106	306
Gillingham Grammar School	75	98	173
Shaftesbury Grammar School	75	100	175
Wimborne Grammar School	25	150	175
Total	£625	£454	£1,079

STAFFORDSHIRE (95-96).

The committee make grants on apparatus and fittings to grammar schools, secondary schools, and and other institutions which have not yet received grants directly or indirectly, *e.g.*, through urban authorities or local committees either from the County Council or the Science and Art Department. These grants will be given on the following conditions:—The amount will not exceed 50 per cent. in the case of apparatus and 20 per cent. in the case of fittings on the cost price.

The committee will also give aid in teaching technical subjects, or towards the salary of additional masters to teach these subjects, applications always being considered on their merits. Schools to which such grants are given to be available for the purpose of county examinations without further charge beyond such reasonable expenses as must necessarily be incurred. The following is a list of grants voted to grammar and secondary scools during the year 1895-96:—

		£	s.	d.
Newcastle High School,	Teaching ..	125	0	0
Newcastle Orme Girls' School,	Teaching ..	20	0	0
,, ,,	Apparatus..	5	0	0
Lichfield Grammar School,	Apparatus..	2	7	6
Longton Endowed School,	Building ..	187	10	0
,, ,,	Apparatus..	10	0	0
Rugeley Grammar School,	Teaching ..	25	0	0
Stafford Grammar School,	Teaching ..	88	0	0
Stone Grammar School,	Teaching ..	10	0	0
Tamworth Grammar School,	Teaching ..	30	0	0
Uttoxeter Grammar School,	Teaching ..	100	0	0
,, ,,	Apparatus..	10	0	0
Total...........		£612	17	6

Travelling teachers are also employed, thus largely increasing the value of the aid.

Upon the vexed question as to how far all this aid has been good for the *Schools*, it is not my province to enter.

We may agree with Mr. Sadler, of the Education Department, on the one side, that "The struggle between letters and science—a false antithesis in many respects—for a long time made (and makes) questions of curriculum needlessly controversial," and that "the study of physical science has profoundly altered our conception of education, and by influencing psychology, has opened the way to a clearer conception, of educational principles," or with Dr. Scott, of the Head Masters' Association, on the other hand that "Schools inadequately endowed, are tempted to sacrifice efficiency in secondary education to the object of obtaining immediate relief under the conditions of 'technical instruction' as interpreted in different localities." But no one can deny that it has been good for the community for science to take its place in every educational sphere, to move in proper surroundings, and to be treated with proper respect. This aid also has enabled it, under the guidance of men like Professor Armstrong, to emerge from the degradation of a mere "subject of instruction," so as to perform the lofty function of a "means of education."

Just one word of practical warning. It must be plain that the aid given by means of capitation payments, whether from the Department of Science and Art, or from the County Councils, must tend to drive the students and the needier schools in the direction of a distorted curriculum. Grants, however, of lump sums of money for efficiency, apart from numbers, aid the *whole* of the school, as well as the specific subjects by setting free other school funds for the support of the literary side; this alone is ample justification for the proposals of the recent Departmental Committee on Science aand Art grants, that for the future all aid to the schools should come through *one* channel—and that the local one—as it has the power to guarantee fixed sums in advance, and possessing itself the power of the purse to relieve the school of those financial risks, so fatal to the smooth development of the work of the teacher.

Hitherto I have said nothing on the subject of scholarships and exhibitions tenable at or leading from secondary schools, but awarded under the provisions of the Technical Instruction Acts. On this subject I prefer to be brief for two reasons. In the first place, I am a little doubtful as to the actual good done to scientific education, *in all cases*, by these scholarships. Where the local authority has first made the technical instruction in the secondary schools efficient and then sent such scholars and such only as have proved themselves likely to profit by *this kind of education*, great good has resulted. Head masters of the classical type have in this way been taught the needed lesson that science is not the dunces' subject.

Of the 42 authorities awarding scholarships, leading pupils from elementary to secondary schools, seven only make a knowledge of elementary science a *sine qua non* in the examination, while of the 21 requiring drawing a large number allow girls to take needlework instead. Of the 27 authorities giving exhibitions open to pupils from secondary schools and taking them on to universities or university colleges, 14 only insist on a knowledge of science as one of the subjects of examination. Thus, in the area of the great majority of authorities, the subject of science has still failed to take its proper position in scholarship examinations.

Secondly, the whole question has been very fully dealt with in the Record of Technical and Secondary Education of April, 1896.

It is there mentioned, that in the year 1894-5, 70 authorities awarded 11,669 scholarships, or exhibitions of one sort or another, of the total value of £94,512, Derbyshire, Norfolk, Staffordshire, and Yorks (West Riding), having the largest number of scholarships ontside London.

For the special purpose of this paper the following two years' comparison has been made:—

Sums expended by Local Authorities in providing scholarships tenable at secondary schools (including awards and renewals).

In 1893-4 ..	£19,000	by 30 authorities.
„ 1894-5 ..	£22,000	„ 42 „
	£41,000	

The action of the Joint Scholarship Board in fostering the teaching of elementary practical science in primary schools by means of a minor scholarship syllabus based upon Course H of the Class subjects of the Day School Code, and in making the elements of mechanics, physics, and chemistry *compulsory*, for literary and commercial as well as for scientific candidates, for major scholarships are likely to have far reaching effects in utilising even scholarships for improving the technical teaching in various classes of schools. Derbyshire, Kent, and Surrey already use these syllabuses. Unfortunately, the want of a central authority to teach these lessons to the various independent examining bodies with vested interests, which regulate scholarship examinations in various parts of the country, has prevented this example spreading as rapidly as we could desire.

In concluding this paper, I wish to gather up the threads of the two lines of progress I have shown as tending towards secondary education organisation, those of the Science and Art Department, and of the Local Authorities, and to show the effect of the action of the latter upon the final product of the development of the former.

Organised science schools, the secondary education branch of the work of the Department of Science and Art, are now rapidly altering their character.

Originally the idea, as was shown earlier, was taken up by School Boards almost entirely. Fired by an ambition to fill an acknowledged void in the lower ranks of secondary schools, the School Boards of large towns entered into an alliance with the Department for the promotion of the higher grade organised science schools.

The old secondary school was still in the clutches of tradition, and despised the work of the Department instead of trying to utilise and reform it.

As a result in 1892 there were 39 organised science day schools in England. Of these, 24 were higher grade elementary, 8 technical, 7 only secondary schools. The elementary influence was in a majority over the other two combined.

Then came the local authorities with their grants, with this result—

In 1897 there are 137 organised science schools in England. Of those 63 are higher grade, 28 technical, and 46 secondary. Thus the *protegés* of the County Councils have when combined a majority of 11 over the representatives of the original type of school, and it is no longer correct to speak of an Organised Science School as if it were essentially the same thing as a Higher Grade School; the time appears close at hand when they will be essentially different.

Thus, whether it be in reforming our old grammar schools by giving them opportunities of forming a science side in no way less efficient than those other departments of teaching upon which they have so long prided themselves, or in establishing, for new centres of population, new schools of a type suited to industrial requirements, or in capturing the machinery designed by Government departments or other authorities, to fit a state of affairs now passing away, the County and Country Borough Councils have, I think I have shown, justified the dictum of one of the principal of those who would wish these things were otherwise, Mr. Addiscott, the President of the National Union of Teachers, when he said this year at Swansea:—

> "The educational work of our County Councils was gradually bringing about something resembling the German Real-Schule, and was doing so to such an extent that if a scheme of secondary education were much longer delayed, it would become unnecessary."

SOME SUGGESTIONS FOR THE BETTER ORGANISATION OF EXAMINATIONS—MORE ESPECIALLY IN REFERENCE TO THE QUALIFICATION OF TEACHERS OF TECHNICAL SUBJECTS.

By W. Vibart Dixon,
Clerk to West Riding Technical Instruction Committee.

Introductory.

For some time past I have been endeavouring in accordance with the wishes of the Committee for which I act (the West Riding Technical Instruction Committee) to formulate a scheme which might afford a practical solution to some of the difficulties the County Council has met with in reference to the qualifications of teachers, and examinations generally. Therefore, when I received from Sir Henry Wood a request to read a paper, I ventured to hope that it might be considered not inopportune if I availed myself of the present occasion to bring forward the subject.

I must remind the Congress of the circumstances under which the County Councils were called upon in the year 1889 to discharge their new duties under the Technical Instruction Act. There was no central education authority, no system of registration of teachers, no organisation capable of welding together and harmonising the heterogeneous bodies charged with educational functions, no national system of secondary education; and we still look for help from the Legislature in these matters.

On the other hand, we had in existence a very great variety of schools and classes and other organisations, while new ones were rapidly developed.

Evidently one of the first things demanding consideration was the competency of the various teachers to give that efficient technical instruction which under the provisions of the Act, we had to aid.

We at once turned to see how far we could look for guidance and help to the Government Departments responsible for educational matters and to bodies like the City and Guilds of London Institute, and the Society of Arts, first with a view to ascertaining the qualifications of the teachers, secondly to supplying the necessary training and examinations to supply deficiencies. And now we were confronted by the difficulties caused by the fragmentary and almost haphazard manner in which so much of the educational system of this country has been built up.

Some of these difficulties will be very apparent if the various subjects of technical instruction are grouped in reference to the Government Departments or other bodies by whom the work is aided or directed, with a view to considering what provision is made as to the training and qualifications of the different classes of teachers of technical subjects.

GOVERNMENT DEPARTMENTS.

The Education Department.—Under the Education Department we have evening continuation schools which to an increasing extent are supplying that preliminary teaching which must be the foundation of more advanced technical instruction.

Here any certificated day school teacher, or any other person approved by the Department, is recognised as qualified. Certain conditions are, however, laid down in the cases of cookery, laundry, and dairy work, but otherwise the regulations of the Department do not in themselves afford any guarantee of the ability of the teacher to give instruction in the technical subject he teaches.

The Science and Art Department.—I now come to the science classes and art classes carried on under the regulations of the Science and Art Department, and dependent mainly upon its grants.

A teacher of a science subject must have one of the qualifications mentioned in the Department's regulations, including, among others, a University Degree in Science, a diploma granted by the Department (without regard to any particular science subject) or the Department's first-class certificate in the particular science subject he is to teach. But no guarantee is afforded by such certificate of any general grounding in science, and none of the qualifications recognised by the Department in either science or art necessitate training in teaching methods.

I must now refer to the recent proposals of the Departmental Committee, which reported last month. These proposals will, if carried out, enable the Science and Art Department to examine more critically the qualifications of the teachers. At the same time, it is evident that a greater degree of responsibility for these matters will be thrown upon County Councils, as education authorities, than as a rule they have hitherto taken upon themselves. And here may I bear testimony to what has been done by those who guide the Department for better adapting their system to meet recent developments.

Other Government Departments. — In reference to Government Departments, I may refer to the Statutory examinations affecting particular trades.

Thus, for the purpose of the Home Secretary's certificate, qualifying for the post of manager or under-manager of a coal-mine, Boards for Examinations are established under the Coal Mines Regulation Act, 1887, for the different coal-mining districts, but there is no general standard recognised by the various

Boards throughout the country, and no common action, as between the Science and Art Department (in whose classes the miners receive instruction) and the Home-office, as regards either syllabus or examination. Nor has the Technical Instruction Committee any representation on the Examination Boards.

And now, in reference to the registration of plumbers, a thing desirable in itself, we are threatened with yet another Board of Examiners, to be constituted without regard either to the Science and Art Department or county councils, though recourse must be had to the classes aided by these bodies for instruction in the principles of the trade.

Further examples might be given under this head, but I have said enough to show how disjointed is our system in whatever direction we turn.

City and Guilds of London Institute.

I next come to the classes which are generally described as technological, largely intended for artisans, where principles are taught in their more direct applications to particular trades and occupations.

Such classes are generally conducted under the regulations of the City and Guilds of London Institute, by whom series of examinations are held for students, but not for teachers, except in wood work and metal work.

The regulations of the Institute provide for the registration of persons qualified as follows to be teachers in technology:—

(a). Any person who has obtained a full technological certificate in the honours grade of the subject to be taught.

(b). Any person who is engaged in teaching science under the Science and Art Department, and who gives satisfactory evidence of having acquired in the factory or workshop a practical knowledge of the subject to be taught.

(c). Persons possessing special qualifications, to be considered by the Institute, for teaching technical subjects.

No grants in aid are now given by the City and Guilds of London Institute, and the technological classes, which often require costly appliances, are mainly carried on by means of grants from the county councils.

It is important to bear in mind that a number of the trades and occupations dealt with are local, consequently different places have very distinct needs, both as regards syllabus and examinations.

Subjects not classed above.

Within the limits of this paper I need only mention further the classes held under the regulations of County Councils outside the sphere of any Government Department or of City and Guilds of London Institute.

These may be grouped as follows:—

Modern languages.

Commercial subjects.

Domestic subjects.

Manual instruction.

Principles of various agricultural subjects and occupations.

Sundry Examining Bodies Granting Diplomas or Certificates to Teachers or Students.

It would be impossible to enter here upon any detailed discussion on the various examining bodies. It is enough for my present purpose to point out that in a large number of cases the examination, though perhaps suitable for the average student, does not suffice for teachers, that in not a few instances there is no guarantee that the examinations are of an independent character, and lastly that there is nothing to prevent any number of new, and, it may be, wholly irresponsible Bodies from entering the field.

With this multiplicity of examining bodies we find that some of the less popular and more difficult subjects are altogether unprovided for, and in other directions redundancy and overlapping.

Action in the West Riding and in other Counties.

I must now return to the work of the County Councils.

Undoubtedly there was not at first anything like an adequate supply of qualified teachers, but men and women eagerly presented themselves at the training classes everywhere established, and speedily became furnished with credentials in the shape of diplomas and certificates granted by the numerous bodies I have referred to, some of whom had sprung immediately into existence to meet the new wants. The teachers thus armed requested recognition by the County Councils, who (I now speak for the West Riding) found themselves obliged to enquire into every individual case and to ascertain the value of the diploma or certificate which was presented. Evidently many of the diplomas and certificates could not be regarded as giving any satisfactory assurance of efficiency, and it was frequently necessary to provide supplemental courses in England or abroad for the further training of the teachers.*

This preliminary stage having been passed through, there sprung up a demand both from the teachers who had qualified, and also from the committees managing the schools, for the establishment of an authoritative list or register of teachers recognised by the County Council.

In response to this demand, and to facilitate its own work, the Technical Instruction Committee determined in the year 1896 to institute a register of teachers of technical subjects, and to make registration of the teacher a necessary condition of grant.

We now have on the West Riding register 880 teachers. The aggregate number of registration entries is 2,179, and the number of class subjects included is 78. Some of the registrations are provisional and subject to a condition that further training shall be proceeded with, due provision for such training being at the same time made by the County Council.

The register necessarily includes a large number of teachers attached to county borough schools, at which West Riding residents are taught, and which therefore come under the purview of the County Council.

So much for our own experience in the West Riding, now as to others.

Through the courtesy of the secretaries of the technical education committees of a number of counties and county boroughs, I have been furnished with information as to the action of each in reference to the subject I am dealing with. Each County Council has been confronted by the same problems, and each has had to solve them for itself. It follows that there is nothing like uniformity of practice or of standard, and a teacher may find himself recognised as qualified in one county or borough but not in the next.

The difficulty has clearly been much the same, whether, as in the West Riding, the County Council is a supervising body, or, as in some other cases, it is not only a supervising, but also a teaching body.

EXAMINATIONS FOR STUDENTS.

I must now refer very briefly to examinations for students, whether teachers or not, on the result of which certificates are granted.

It is found that there is already a widespread demand from students for certificates implying a certain standard of merit as ascertained by examinations, and it is evident that the requirements in this direction will grow. Organised courses for teaching the principles applicable to trades or occupations, extending from five to seven years, have been established in the West Riding, and similar action is being taken elsewhere. Already there are suggestions for the grant of diplomas and degrees in technology.

Meanwhile a number of County Councils have already granted certificates indicating proficiency, and I am informed that these are recognised by the local employers as having a distinct value.*

This being so, it is the more essential that, in the grant of certificates implying a certain training and capacity, a definite standard should be preserved, and that some credential should be available which should be everywhere accepted. Otherwise there can be no doubt that the multiplicity of certificates and their varying worth must tend not only to confuse, but to destroy the value of the whole.

SUGGESTIONS.

I will now pass on to describe the suggestions which I venture to offer.

In the first place, I would propose that the County Councils, acting through their technical instruction committees, should by concerted action do that which they have been endeavouring to do single-handed, and that accordingly they should take steps to form an association for examination purposes; but the scope of the work of such an association might evidently be extended in other directions.

The association should not be itself an examining body, but essentially an organizing and advisory body.

Among its chief objects would be :—

1. To co-ordinate the existing educational machinery in reference to examinations

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* Since the passing of the Technical Instructions Acts, the West Riding County Council has granted 1,980 exhibitions for the special training of teachers, the total expenditure under this head having been £5,600. The same teacher has frequently held several exhibitions for different subjects.

* The West Riding County Council has this year instituted voluntary examinations of students in its aided classes in shorthand, book-keeping, business methods, French, cookery, and laundry work, and is issuing certificates to those who pass a certain standard. 1,360 students presented themselves, so that it is evident that these examinations to a certain extent meet a distinct want. This step has been taken experimentally, with the intention of taking further action as soon as practicable to secure suitable examinations (not necessarily uniform) by a duly recognised body acting for the entire country or for a number of counties in association.

for teachers, and for this purpose to confer with and make representations to government departments and teaching and examining bodies, with a view to ensuring that suitable provision is made for the proper training of teachers, and for the imposition of suitable examinations.

2. If satisfactory provision cannot be made through existing agencies for the above purposes, to organize one or more boards of examiners with a view to supplying deficiencies.
3. To take steps to prevent the undue multiplication of examinations, expecially by irresponsible bodies or persons. At the same time to endeavour where necessary to consolidate existing bodies so as to secure greater efficiency, and prevent waste of money and other resources.
4. To perform similar duties in reference to schemes of instruction, syllabuses and examinations for students, with a view to the ultimate grant of suitable certificates or diplomas.
5. To consider any proposals from individual County Councils, or groups of County Councils bearing on the above subjects with a view to making suitable provision for a particular locality, whether by the adoption of a local scheme of examinations as part of the authorised scheme of the association, or taking such other steps as the circumstances may require.

Constitution of Association.

Central Association. — Each Technical Instruction Committee to appoint say two representatives on the Central Association, secretaries of the committees being authorised to attend and speak.

With these representatives may be associated representatives of Government Departments and other bodies engaged in education. I need not here attempt to particularise who these should be, but it appears to me desirable that the Education Department, the Science and Art Department (or a central education authority if established by law), the City and Guilds of London Institute, and the Society of Arts should be represented, as also certain of the universities and schools affording technical instruction.

Whether any bodies directly interested in the decisions of the Association should be members, or only attend in a consultative capacity and without vote, would be a matter for consideration.

The Association would naturally have an executive committee, and sub-committees.

Provincial Associations.—While advocating a Central Association as being the best means of securing the co-ordination which is necessary in reference to matters of national concern, I by no means propose an undue centralisation of the work.

To prevent any such over-centralisation, and to facilitate organization throughout England, I suggest the formation of Provincial Associations constituted on lines very similar to those proposed for a Central Association; and these Provincial Associations would be federated with the Central Association.

It would be premature to define what should be the area of a province, but taking my own county, it seems to me that we should naturally work with the Yorkshire College and Firth College in such a matter, and we might perhaps take Yorkshire as a province, constituted as follows:—

Administrative Counties.		County Boroughs.		Total of County, including County Boroughs.
Name.	Population.	Name.	Population. 1891.	
East Riding...	141,516	Hull	200,044	341,560
North Riding.	284,837	Middlesbro'.	75,532	360,369
West Riding..	1,351,570	Bradford ...	216,361	
		Halifax ...	89,832	
		Huddersfield	95,420	
		Leeds	367,505	
		Sheffield ...	324,243	2,444,931
		*City of York	—	67,004
Total population				3,213,864

* Situate within all three Ancient Ridings.

Each county council would send such number of representatives as might be agreed upon between them.

It may be doubtful whether all our county boroughs would immediately join, though they would hardly hold aloof for long. One county borough has already arranged with us provisionally for a joint inspection of classes and schools.

For some purposes it is probable that two or more Provincial Associations would be linked together; on the other hand there might be sub-committees for individual counties.

The Provincial Association would, where necessary, formulate its own proposals for examinations, and when desirable submit them to the Central Association for its adoption. Any scheme so adopted, though perhaps only local in its practical application, would have the imprimatur of the Central Association.

By means of such Central and Provincial Associations it might be practicable to bring such bodies as the City and Guilds of London Institute and the Society of Arts into much closer touch with the provinces, and thus the local wants might be much better served.

It is with great difficulty that the City and Guilds of London Institute can be induced to alter its syllabuses and schemes, or to approve of organised schemes specially intended to meet local requirements, and I may say the same as to the Society of Arts. Some time since we asked the Society to institute examinations suitable for teachers of commercial subjects. The reply was that our wants might not be shared by the rest of England, and the request was declined. But we, with our great industrial and commercial population, cannot afford to wait for the rest of England. Hence my anxiety that adequate provision shall be made for the provinces.

FINANCES.

The expenditure of such an Association as I have described would be small, and I do not think there need be any serious difficulty as to the financial arrangements; at the same time the subject cannot with advantage be discussed here.

GENERAL REMARKS AND CONCLUSION.

1. The plan I have advocated is intended to promote united and consistent action by the education authorities of counties and county boroughs as a whole, at the same time preserving freedom of local action.
2. It would bring County Councils individually and collectively into close touch with Government Departments, and with teaching and examining bodies.
3. No legislation is requisite for its accomplishment.
4. The Associations would be elastic in character, and capable of such amount of recasting as experience and altered circumstances might from time to time require.
5. Should a central education authority be established by legislation on the lines suggested by the recent Royal Commission on Secondary Education, and a statutory body created for the purpose of registration of teachers, the work of the central and provincial associations I am advocating would be somewhat modified, but the need for their continuance as advisory and organising bodies would be quite as great as now, and in some directions even greater, by reason of the field occupied by county education authorities having been enlarged. Meanwhile the work of registration of teachers would have been greatly assisted by their action.

I therefore venture to think that some such scheme as I have endeavoured to outline would be found helpful to the cause of education in this country at the present time.

Sir HENRY TRUEMAN WOOD, with regard to Mr. Dixon's remark that the City and Guilds of London Technical Institute and the Society of Arts were very loth to alter their habits, said he supposed that even the Society of Arts was subject to human infirmity, and perhaps its executive had the natural and official dislike to the trouble which change always involved. But making allowance for that he thought it was not difficult to find reasons for not adopting all suggestions for alteration. Mr. Dixon had remarked that when he asked for an examination of teachers, he received a reply to the effect that probably the requirements of other districts might not coincide with his own. Now, it was not so much that the requirements of different districts might not coincide, but, as a matter of fact, they received innumerable applications from the different districts and different institutions, which were not compatible. For instance, there were two sorts of criticisms which they received regularly after each examination; one was that the standard was so high that it was no use for the candidates to enter for the examinations, and the other was that the standard was so low that the examinations were contemptible, and were of no value at all. He could say the Society of Arts was most anxious to keep its system of examinations up to date, and to modify it as required. During the last few years their examinations had been constantly modified, and he hoped they would go on being modified. The question of the examination of teachers was a very difficult one. If it was meant to test a teacher's knowledge of a subject, any good examination, so far as an examination could test knowledge, would do that; but if it was intended to test a teacher's capacity for teaching, no examination had ever been invented which would do that. If anyone could devise a good system for the examination of teachers, he was quite sure the Council of the Society of Arts would be only too pleased to adopt it. With regard to the proposals made by Mr. Dixon for general examining bodies, he was quite sure the Society of Arts would be only too glad to hand over the system which it had carried on now for 40 years with success, to any more capable body. Twice in previous years it had offered to abandon its own examinations, and twice from pressure from outside it had resumed them. The Society had spent a considerable amount of money in founding its system of examinations, and if for the last three years or so they had become self-supporting, for the previous 37 years there had been a heavy annual expenditure on them, and he did not think the Society would be at all sorry if it could hand over those examinations in the same way as it handed over the technological examinations. Mr. Dixon also remarked that the West Riding County Council had this year instituted voluntary examinations in shorthand, book-keeping, business methods, French, cookery, and laundry work. In most of those subjects the Society of Arts provided examintions, and he (the speaker) did not quite see the necessity for instituting additional examinations in the same subjects, unless the standard of the Society was too high, or unless, which was less likely, it was too low.

Mr. HENRY HOBHOUSE, M.P., said he felt sure Mr. Dixon did not desire, any more than anyone else who was acquainted with the multiplicity of examinations, to create an additional examining body. What they wanted was rather to co-ordinate the existing examining bodies, and, as far as possible, to amalgamate them or bring them into harmony. He ventured to think that that could only be done by some such central body as was suggested by the Royal Commission on Education. He did not think any voluntary association or local authority would have sufficient influence or sufficient power with the present examining bodies to make any great changes in that direction. No doubt such a local association as Mr. Dixon proposed might be of very great use, but he looked forward to the organisation of a central authority as a necessity before we could get our examinations better co-ordinated and placed on a better footing. With regard to the interesting paper which had been read by Mr. Macan, he thought all present must have been impressed with the amount, the valuable character, and the great variety of the work that had been done by our County Councils in technical instruction during the last few years. But he hoped it would not induce any member of the Congress to go away with the impression that so much had been done, and so much was being done, that little more was needed in the field of legislative action. Speaking as a practical worker in one of the counties of England in technical instruction, he felt convinced that three things were needed before the work of the County Councils on technical instruction could be placed on a satisfactory basis. First and foremost, these funds must be permanently appropriated to education. No doubt in certain counties, possibly in Surrey, in the West Riding, and other counties, where there was a vast enthusiasm for educational work of all kinds, it might not be considered necessary to make a change in the law in this respect. But there were counties in England, he was sorry to say, where that enthusiasm did not exist, where there was sometimes a tendency, a passing tendency, under the influence, say, of agricultural depression, to devote these funds to other purposes than education. Local administrators, who were naturally, like other representatives, subject to a certain amount of pressure from their constituents, felt, in such times, difficulties in the way of carrying on the regular and uninterrupted educational work to which these funds ought to be devoted. Before many months were over the Legislature ought definitely, and once for all, to devote these funds to the purposes of education. Secondly, the sphere of their work under the Technical Instruction Act ought to be extended. As Mr. Macan had shown by his figures, different County Councils took different views of what their duties were. Some devoted large sums to secondary schools, others expended little or nothing on secondary schools; many devoted large sums to improving evening continuation schools, which, in the eyes of others, was the work of the Education Department. When the money was secured to educational purposes they needed to know more clearly than they did at present what those purposes were to be. And, thirdly, in order to carry out technical instruction work in connection with secondary schools, the local authority, properly constituted, ought to be able to exercise some general supervision over all local secondary schools. Nothing could be more unsatisfactory than having to deal with one department of a school, and having nothing to do with another—having complete jurisdiction over science and art subjects, and nothing to say upon literary subjects. No school could be carried on satisfactorily under those circumstances, except by accident. The Legislature ought to give to the local authority the reorganisation of secondary education, and it ought also to give them some general jurisdiction in the interests of science and art subjects.

Mr. T. TURNER (Stafford), referring to the remarks made by Sir Henry Trueman Wood on Mr. Dixon's paper, said there must naturally be considerable difficulty in altering the syllabus for an examination, when a department or a society was dealing with the whole country. But where a comparatively small number of students had to be dealt with, his experience had shown that the Department and the City and Guilds of London Institute were ready to alter their syllabus in order to meet local requirements. Referring to Mr. Macan's paper, he said Mr. Macan had given them a very interesting account of the work of the County Council, particularly in connection with secondary education. Mr. Macan referred to an important point when he said the Technical Instruction Act made no class distinctions. He (the speaker) had certainly found the better working-classes and the lower middle-classes were the most suitable portion of the community for the purpose of technical instruction. Well-to-do people could take care of themselves, and the very poor did not really appreciate the education that was being offered to them. The education given should be sufficiently good for the middle-class and sufficiently cheap for the poor. He was always pleased to see the middle-classes attend all forms of instruction, as it helped to set the fashion. The poor man was apt to say, if it was not good enough for the well-to-do, it was not good enough for him. His experience was that they could not start country classes with the poor people; but if the first year some of the better class people of the village would attend, the next year the poor people would come too.

Professor SILVANUS THOMPSON said the statement made by Mr. Dixon that the City and Guilds of London Institute examinations were difficult to modify caught his ear, because he happened to have the honour of sitting on the Examination Board of the City and Guilds Institute which had the appointment of examiners, and so far as his memory went, for the last three or four years there had been no meeting of that Board at which they had not made some alteration in some syllabus. They received a good many complaints, and some teachers complained that they were continually changing their syllabus from year to year, One thing they had particularly tried to do: where, as for example in the textile industry, there was a good deal of difference between the technical terms used in different parts of the country, they had taken precautions to have more than one examiner, and not to choose both examiners from one district. Referring to Mr. Macan's paper, he said he had himself in past years criticised the operations of the Science and Art Department. He had criticised their regulations about qualifications of teachers and so forth, and he was quite certain that very great progress had been made by the Science and Art Department, not only within the last year or two, but for the last seven or eight years. The Science and Art Department, though a Government Department, was after all human, and amenable to criticism. If we were not so anxious about offending the Department, and if we were more free and frank in our criticisms, we might get a good deal more than we had got in the past from that august body. The reforms and modifications that had taken place in the programme of the work of the Science and Art Department coincided with the administration of Captain Abney. He (the speaker) believed we had in him an exceedingly good and intelligent friend to the technical education movement, and many of the reforms that had been carried out were due to his perception that the time had come for change. Returning to Mr. Dixon's paper, he cordially emphasized the danger of multiplying examinations. Anything that could be done toward co-ordinating the work so as to simplify the machinery and the number of bodies that were attempting to examine, and that would at the same time give us a really workable scheme of examinations, and as little of them as possible in secondary and technical education, would be helping on a good work. We must not allow new bodies to duplicate what was already being done by old ones. The evil of certificate hunting, which was now deplorably prevalent, would become more prevalent if we had competing bodies giving certificates for the same thing.

Mr. THOMAS COPE (Leicestershire) said Mr. Macan in his able paper had made some remarks with regard to education generally, and particularly pointed them with regard to what he called the education of the "captains of industry." He did not know whether Mr. Macan meant that we ought to be able to teach our chemists in England, and not have to send them to Germany to be educated. If that was what he meant, County Councils were too small to take up any such work as that. When they came to teaching the captains of industry, that was to say, giving the very highest possible education in highly specialised subjects, he thought they would find very great difficulty in entrusting that work merely to County Councils and local bodies, because they had neither sufficient money nor sufficient pupils to properly do the work. In the district with which he was connected they had found it necessary and advisable to combine four counties in order to teach the one special subject of dairy industry. With chemistry and electricity, and such subjects, he thought the difficulty would be greater still, and if they wished to give the education in England there would have to be a gathering together of all the County Councils, and other municipal bodies at one great centre, or else the work ought to be undertaken by the State.

The CHAIRMAN said he wished to re-echo the words of the last speaker; the whole organisation of this technical education ought to come from the State. One thing that was absolutely necessary was that there should be a sufficient number of capable teachers. Unless the education of the teachers was thoroughly sound the instruction which they gave to others would always be unsatisfactory.

THE LIMITATIONS OF THE WORK OF COUNTY COUNCILS.

By THOMAS TURNER, A.R.S.M., F.I.C.

(Director of Technical Instruction to the Staffordshire County Council.)

As the work done by County Councils has been one of the most striking developments in the progress of technical instruction in England during the past seven years, an outline of the conditions under which this work has been conducted may not be without interest to the visitors to this Conference, even though much of what may be said may be an old story to those who are themselves connected with county technical instruction committees. The limitations under which this work is conducted may be conveniently considered under three heads.—(1) The legal conditions under which technical instruction may be supplied; (2) limitations arising from the area and income of county authorities; and (3) the condition and previous education of the pupils taught.

I. The first Technical Instruction Act, which was passed in 1889, has been extended by an Act passed in 1891, while additional facilities for the acquisition of land were afforded by a further Act passed in 1892. The fundamental conditions of the Act of 1889, however, remain unaltered, and, speaking generally, have been found to work satisfactorily. The most important provisions of the Act of 1889 are the following:—

(*a*). That the local authority shall not supply or aid the supply of instruction to scholars receiving instruction in the obligatory subjects at an elementary school.

(*b*). That a pupil shall not be required to attend at, or abstain from attending at, any place of religious worship, or any religious service.

(*c*). That aid shall not be given to any school conducted for private profit.

(*d*). Technical instruction shall not include teaching the practice of any trade, industry, or employment.

As the above are the chief limitations contained in the Act of 1889, which confers definite powers upon local authorities, it will be seen that these authorities are allowed great freedom in their choice of subjects, methods of instruction, and general procedure, and are practically independent so long as their expenditure, as certified by the Local Government Board auditor, comes within the above and certain other minor conditions. Though no provision is made in the Act for the teaching of literary subjects, aid may be given to the technical side of a school which also teaches literature or languages, so that indirectly considerable assistance can be given to the study of literary subjects. The whole field of education beyond the elementary school is thus open to the County Council, so long as aid is not given to institutions with a definite religious bias, or to those conducted for private profit, nor must the practice of a trade or profession be taught. The last regulation has led to many interesting questions being raised as to exactly where the teaching of a trade begins, and the teaching of the principles underlying that trade ends, and while it is universally recognised that the professional training of a solicitor or a medical man is outside the Technical Instruction Act, it has only recently been decided that the training of nurses is illegal, while the teaching of plumbing, or of hedging, ditching, thatching, and other manual processes of agriculture, is regarded as coming within the Act. Generally speaking, the regulations in reference to schools conducted for private profit, or those without a conscience clause, have worked well and given satisfaction, but it must be acknowledged that a number of cases of hardship have occurred with schools on the borderland, since the best of the private schools are incomparably better than many of the smaller endowed schools, and some of the high schools attached to particular religious denominations have done a public work for which no recognition is provided under the Act. Still, as before stated, the limitations have, on the whole, worked well, and any proposals to give relief in special cases of hardship would need to be considered with the greatest possible care. One of the advantages of the Act of 1889, is the elasticity of the provisions under which local authorities work, and County Councils have not been slow to avail themselves of the reasonable freedom thus conferred.

II. Passing next to the limitations arising from the area and income of county authorities, it must be remembered that generally speaking the County Council or County Borough Council is not a large unit, as there are in England, excluding the county of Monmouth, 49 county councils and 61 County Boroughs, or a total of 110 county authorities. Apart from London, which may be regarded as altogether exceptional, the average population in each area would not much exceed a quarter of a million, while in some few cases it is little over 50,000. Owing chiefly to this smallness of the unit, county authorities have done comparatively little in the direction of university teaching, or the founding of university colleges, while for other teaching of the highest class it has not unfrequently been found advantageous for two or more counties to combine together. It is doubtful whether, under present conditions, a university college could be successfully conducted with a population of much less than half a million. There are, however, only nine counties with a population of 500,000 or upwards. Of these, Durham, Staffordshire, West Riding of Yorkshire, Lancashire, Kent, and Surrey, were already provided with university colleges either in their own areas or on their immediate borders; while Cheshire and Essex, though not quite so conveniently placed, were still not far from facilities for higher instruction. The remaining county, Devonshire, was thus the only one among the most populous counties which was not within reasonable access of higher teaching at the passing of the Technical Instruction Act. It is not, therefore, surprising that County Councils have done little in the direction of establishing colleges of university rank. Considerable sums of money have, however, been spent in the provision of higher instruction as applied to agriculture, horticulture, and dairying, and the College at Wye, the Midland Dairy Institute, the Holmes Chapel School, and the Extension College, at Reading, will serve as examples of many similar institutions which have come into existence during the last few years, chiefly owing to the work of County Councils. The needs of Devonshire have also to some extent been met by the provision of a University Extension College at Exeter.

For reasons somewhat similar to those above given county boroughs also have not expended much of their income on work of a university type, and University College, Nottingham, is probably a unique example of an institution of the kind founded and supported by the local authority. The function of the County Council or County Borough Council has thus been chiefly that of taking the pupils who have left the elementary school and supplying or aiding the supply of almost all forms of education between the elementary school and the university college. Large sums of money have been spent in providing technical schools, at which instruction of the highest obtainable type has been given in relation to local industries, while scholarships have been provided to enable suitable persons to proceed to a university course. The special characteristic of the work of County Councils has thus been the local supply of further instruction to persons who have already left the elementary school.

The funds available for the purposes of technical instruction consist of the residue under the Local Taxation (Customs and Excise) Act, amounting in the aggregate to about £750,000 per annum, and contributions from the local rates, which may not exceed 1d. in the £ on the rateable value. Speaking generally the local rate is never raised in rural districts, but in urban districts, each year an increasing amount is so provided, and in Staffordshire alone, during 1896, twenty-six urban authorities contributed money from the rates or other local sources, to meet corresponding grants of the County Council.

In many cases the Exchequer contribution is the only source of income of the technical instruction committee, and is found to be sufficient for present purposes. In others, the Exchequer contribution is supplemented by the full penny rate, and is then found to be insufficient. This is largely due to the basis of distribution, as a result of which some counties or county boroughs, receive less than 3½d. per unit of population per annum, while others receive three times as much per head in the same time. It is only necessary to compare, on the one hand, busy manufacturing towns, like Hanley or West Bromwich, with a population of 60,000, and a grant of 3·7d. per head, with Bath, having a population of 52,000 and 6·4d. per head, or Oxford with a population of 46,000 and 7·3d. per head, on the other hand, to see how the industrial centres, which are the basis of our commercial supremacy, suffer by the present method of distribution. The system presses most hardly upon industrial counties and small county boroughs, which, in view of their manfacturing industries, are more in need of technical instruction than any other part of the country. State aid to elementary schools and to Science and Art Department classes is distributed according to the number of pupils taught and the needs of particular districts; and the aid given for technical instruction should be distributed according to some similar rational system. The present method of distribution can lay claim to no equitable or scientific basis, and imposes a most serious limitation on the work of many deserving authorities.

III. Dealing lastly with the limitations due to the conditions affecting the pupils to be taught, it must be remembered that the majority of those who have attended County Council classes hitherto have been persons who have left the elementary school, and who are engaged during the day in some trade or occupation at which they earn their livelihood. It is therefore essential that the education should be provided locally, and in the country districts particularly, no educational facilities are of much use for this class of student if the distance to be travelled is more than about three miles. Further, as the majority of the pupils left the elementary school at an early age, and have forgotten the greater part of the little they once knew, much of the instruction is necessarily of a very elementary character, and the fees charged are merely nominal. Training of a really high type can thus only be provided at large centres of population, or at such institutions as farm or dairy schools, at which the pupils are resident for a considerable period.

The state of things which has hitherto existed must, however, not be regarded as permanent, as the class of pupils which at first flocked to County Council classes will gradually be supplied, and in future it will be possible to raise the standard of local instruction, owing partly to longer attendance at the elementary school, and also to the excellent work done in evening continuation schools, particularly in rural districts.

But after all it must be remembered that the training to be obtained by a young man or woman who attends evening classes, say twice a week, and who is engaged in other occupations during the day, must necessarily be imperfect and superficial. The industrial leaders of the next generation will be largely drawn from those who have been able during their most receptive and retentive years to pursue a systematic course of study. It is for this reason that the question of secondary education occupies so important a position in the public mind at present, and is so closely connected with the proper conduct of every form of technical instruction. It is only by careful training in efficient secondary schools, up to the age of sixteen at least, that pupils can be prepared to take full advantage of the higher forms of technical instruction which are being provided in ever increasing number. County Councils have done much to assist secondary schools by the provision of scholarships, the supply of apparatus, payment of competent teachers, building grants for laboratories and class-rooms, and other similar means. But the powers of local authorities are at present altogether inadequate, and wide districts are unsupplied with efficient secondary schools. For example, in the part of Staffordshire, north of a line drawn from Uttoxeter to Newcastle, there is included an area of upwards of 300 square miles in which are two large denominational boys' boarding schools, but no public boys' secondary school recognised by the County Council as efficient, and only one public secondary school for girls, which was founded by private enterprise, and has only recently been in a position to receive aid from the County Council. Bad as is the condition of secondary education for boys, it is generally even worse for girls, for, starting in another direction from Burton on the extreme east of the county, and passing right through the county to Newport, a distance of upwards of 30 miles, there is not a single secondary school for girls, at which County Council scholarships could legally be held. Nor is there a girls' secondary school between Newcastle in the north and Walsall in the south, again a distance of about 30 miles. So that in an area approaching 900 square miles, though there are five efficient elementary schools for boys, there is no public secondary school for girls. Probably Staffordshire is not worse off in respect to secondary education than many other counties, but what has been said will serve to indicate the grave limitation which is laid upon county technical instruction committees by the present chaotic state of secondary education. All who are interested in the subject are looking forward most anxiously to the proposals of the Government, and hope that at an early date increased powers, which are now so urgently needed, may be granted by Parliament. It is only by such means that a properly-trained body of students can be prepared to take full advantage of the facilities for education now provided by so large an expenditure of public money, and until a good foundation can be secured much of the superstructure must remain in an unsupported or insecure condition.

THE TRUE BASIS OF TECHNICAL EDUCATION.

By W. Slingo,

Principal Telegraphists' School of Science.

The author of this paper first turned his attention to the question of technical education about 23 years ago, and it is hoped, therefore, that this Congress will accept the few remarks which are now addressed to it as expressing the opinions of one who is largely interested in the question, and also as one who has had ample experience upon which to base such opinions.

The author is anxious that the managers of our technical schools and colleges should have some clear and definite course of action laid down for their guidance. At present the state of affairs is, as will be demonstrated in this paper, little short of chaos.

Initially, the real and ultimate aim of true technical education should be set forth. The air just now is full of wild ideas about the general elevation of mankind, the approach of a sort of intellectual milennium, the appropriation of the commerce of the world, and numberless other topics of a similar character, but all of which are being paraded by so-called educationalists as coming within the scope of technical education. The proper test of technical education should be its commercial value, but there is considerable danger of that value being greatly over-estimated. Attention is naturally directed to Germany, where such education has attained its, at present, highest development, and the prominent position which Germans have in recent years acquired in the commercial world has caused many to assume that that position is due entirely to the system of education. The equalizing effects of the telegraph, of railways, and generally of increased facilities for transport and correspondence are of course ignored. It is, however, more than questionable whether if the German system of education had been applied in any other continental country, similar commercial progress would have resulted. The main causes of Germany's progress are to be found in the general industry of her sons, in the determination with which they pursue their objects, in the low rate of wages for which her workmen are content to labour, in the low profits which the masters are content to receive, in the general sense of discipline inspired by her military system, in the greater relative power of capital as compared with labour, in the influence of a fostering government, in their general business capabilities, and last, but not least, in the way in which they utilise their technically-trained men.

In this country a vast amount of money is spent annually on what is termed technical education, and yet so injudiciously is this money spent that there are not wanting competent judges who insist that we should be better off without the results obtained thereby.

From the author's point of view, the first great aim of technical education should be to fit the student for a particular industry, and to give him such weapons as will enable him to prosper in that industry. The result of such education should be that he could perform his own particular work in a superior manner, in a shorter time, and with less expenditure of energy, than he could in the absence of such education.

The necessity for the general adoption of some system of technical education has become more and more evident as the ancient system of apprenticeship has gradually died out. This ancient system of apprenticeship was one admirably adapted to the conditions of life, and to the requirements of the time. The apprentice lived with his master, learned the manual portion of his trade in the shop, and received from his master such instruction as he could or was disposed to give in the arts and mysteries (*i.e.*, science) of the particular industry. The instruction was oral, nothing was committed to paper, and the secrets of the trade were handed down from generation to generation. This system tended to limit the number of entrants into any one trade, and thereby to prevent the overcrowding of any particular labour market. On the other hand, development was hampered by the system; the methods of one establishment did not become known at another; the apprentice had to assume a very humble and often menial position; his life was frequently very hard, the feeding often inadequate, and the flogging none too rare. Nevertheless, a highly-skilled master had at all times many candidates for apprenticeship from whom he, as a matter of course, selected the most promising. Taking all the circumstances into consideration, it is scarcely to be wondered at that the system produced a greater proportion of first-class workmen than exists at the present time. One weak point consisted in the comparative narrowness of the education received, consequent upon the fact that the apprentice had no source of information other than his master or his master's shop.

At the present time it is too often the practice for a lad to enter some firm or establishment as a sort of odd boy; if he picks up sufficient knowledge of the business and does what he can to become proficient in the work, he in time blossoms out as an artisan, but if he neglects such opportunities as may fall in his way he remains a labourer to the end of his days. No attempt is made by the master to educate his boys, and the natural result is a lowering of the standard of skilled labour and the flooding of our markets with shoddy work. In such circumstances, it is not to be wondered at, that the public appreciation of good work has been degraded and the consequence is that the price which has to be paid for good work is very often regarded as sheer extravagance.

It is to the remedying of this defect, to the recovery of the lost ground, that the attention of our educationalists should be directed, but the trouble is that there are generally three parties to be educated, viz., the artisan to turn out good work, the master to see that it is to his interest and credit to pay for good work, and the public, *i.e.*, the purchaser, to recognise that it is to his advantage to have only good work even though the cost be a little higher, for after all the difference between the cost of good work and shoddy is, in the great majority of cases, only a small percentage of the total outlay involved.

It is the purpose in this paper to deal mainly with the workman; let us call him the apprentice although he be little more than a boy doing odd jobs, and picking up such information as may fall in his way; or we may suppose him to be a young fellow who has just been raised to the dignity of a mechanic or an artisan. Whatever, for the moment his exact position may be, he is in one respect, in very much the same position as the apprentice of old. He has picked out for himself, or circumstances have placed him in a particular trade, and he desires to prosper in that trade. He can only pick up the crumbs of knowledge and experience as they fall from the hands or lips of his older comrades, but the great fact remains that *he is in a trade*, he has a trade to follow, and he is anxious to learn all he can about that trade. We are not concerned with that type of youth whose only desire is to do as little as he can in return for his wages, and to ignore altogether the interests of his employer. Such a youth is soon recognised. But to return to the cardinal point. The lad has adopted a trade—the practical lessons he receives, and which correspond to that part of the education of the old-time apprentice which was gained in his master's workshop, are the aforesaid crumbs which he picks up. Where is he to get the counterpart of the explanation of the arts and mysteries as imparted by the master of old time? Clearly this is the breach where our polytechnics and technical schools should step in, and they do step in, but only with one toe of one foot. The rest is left outside; the breach is not filled; the solitary toe soon gets trodden on and is withdrawn, and our poor apprentice is once more without an instructor. To make this important point clear is to demonstrate the inutility of much that is now being done in the name of of technical education. Let us suppose that our apprentice has the incentive to avail himself of the facilities afforded by our polytechnics and technical schools. When he has selected his "institution" he attends for the first time with confidence, but he speedily finds that the men who should be prepared and able to teach him how to become more skilful at his work, might, with advantage, take a few lessons from him. Frequently his would-be teachers are young men fresh from some other technical institution, and the workman discovers that they are merely prepared to coach him up for an examination or two, thus enabling him to obtain certificates but not skill. The examination papers are in too many cases set by some professor guileless of any real practical knowledge and absolutely incapable of coming down to the level of the workman. As both the professor and his assistants who prepare the examination papers for him base their work upon the same books as those from which the teachers derive their information, there can be no doubt that such teachers are or should be well qualified to cram the student so that he can obtain his certificates. Indeed a genuine and really capable teacher dare not waste much time in imparting really useful information to his students, because in a technical institution, the efficiency of a teacher is generally judged by the number of certificates gained by his pupils, and knowledge which is useful to a man in his work is not as a rule worth anything in an examination. In the course of a week or two, then, our apprentice sees through this and grasps the fact that he can derive very little benefit from a course of lectures arranged to be acceptable to and comprehended by the majority of the students (mostly amateurs), and he loses at once any confidence he might have had in the lecturer when the latter essays to describe the fundamental principles of the underlying science in a language unknown to him, when the lecturer proves himself utterly ignorant of workshop practice and language, and when, as generally happens, he describes as current practice, methods which have long since been abandoned. The immediate consequence is that our apprentice, for whom, or such as whom, the class ought primarily to be conducted, will if he be a simple minded man desert the class by the end of the first month or so, and will do his best to dissuade his fellow-workmen from making a similar attempt.

It might be imagined that such abortive efforts on the part of our apprentice would if frequently repeated have the effect of entirely depriving technical institutions of pupils, but unfortunately the very imperfections of the system enable it to survive. The exclusion of the artisan who cannot write neatly and is unable readily to give evidence of his knowledge in an examination paper, is not felt as a serious loss either by the teacher or by the institution. On the other hand, it is a distinct gain, because the field is now open to another class of students, many of whom would hesitate to mix too freely with the average artisan, and consisting largely of youths who have recently been turned out as finished by the Board schools; of school teachers anxious to obtain certificates, no matter what the subject may be, providing that those certificates can be obtained with the minimnm amount of work; of clerks in offices and factories; and of shopkeepers' assistants, with a sprinkling of unskilled labourers and a few craftsmen in other trades anxious to provide a second string to their bow. To such a class of amateurs the teacher, no matter how good or how earnest he may be, must now adapt his lectures, and in the event of a student like our apprentice remaining in the class, he must be content to listen to a vast amount of talk meaningless to him, and often bristling with inaccuracies. For the existing system of examination such pupils are exactly those required by the teacher to obtain good results, and he is assisted rather than otherwise by the distressing fact that few, if any, of his pupils ever have had, or ever will have, either the opportunity or the inclination to test his precepts by practice.

It may, perhaps, be asserted that this doleful picture is altogether overdrawn, but the recital of a few simple facts will suffice as a refutation. One city clerk was in his year the prize carpenter in the United Kingdom, another took the prize in electric lighting, another the prize in electrical instrument making, another in tools, and another who had never been out of London for more than a week or two at a time obtained a certificate qualifying him as a teacher of agriculture. A schoolmaster became a prize electrical engineer, and an ironmonger's clerk a prize electrical instrument maker. Another teacher who had in all probability never seen the inside of a telegraph station blossomed forth as the first prizeman in telegraphy and was inferentially the best trained telegraphist in the Kingdom.

Now the principle of examinations is not to be blamed for these results; the fault lies entirely with the examiners who too often base their examination papers solely on certain text books, ignoring altogether the thousand and one points of detail and application which never get into text books at all. The author has in mind one paper in an electrical technical subject in which twelve of the fifteen questions were based entirely on theoretical electricity and could be answered by anyone who had gone through a moderate course of instruction in electricity, but who had never had any *practical* connection with the subject.

Again, the comparatively illiterate student often fails because of his inability to grasp the meaning of the question. Many a student was floored by a question in a recent paper in elementary electricity, which opened as follows: —"An insulated wire is wrapped for a few turns in a right-handed coil round the core of a ring of soft iron, and then for a few turns in a left-handed coil round the core." *The core of a ring of soft iron* is meaningless, and the examiner probably meant, "A core of soft iron in the form of a ring." In another paper the candidate was asked to "describe and sketch an electric bell, which continues to ring as long as the circuit is closed." There is no such bell. Assuming the ordinary trembler-bell to be the one referred to, the latter part of the question should have read, "as long as the button or other contact-maker is pressed."

Examples such as these could be mentioned by the dozen.

These examinations usually last for three hours, but it is no unusual thing to find one of the eight or ten questions to be answered to involve as much work as would occupy a thoroughly experienced engineer for several weeks. Can we wonder that the candidate is sometimes driven to the conclusion that the examiner is himself in search of information?

Sufficient has been said to demonstrate some of the weak points in the examinations, but the inequity of the present system of technical education may be further illustrated in the following way:—A friend of the author, who is in well-to-do circumstances, has a number of grown-up daughters. A technical school is opened in the neighbourhood; dressmaking is one of the subjects of instruction; our friend's daughters clamour to join. What is the consequence? The poor dressmaker, who contributes to the rates, assists thereby in teaching her own customers to take the bread out of her mouth. Now, those young ladies were quite within their rights in learning to make their own garments, and they were prepared to pay any reasonable fee for their instruction, but instead of a system being introduced which would allow them to do so, they have to pursue their hobby at the ratepayers' expense, the business of the poor ratepaying dressmaker is reduced, and practically the requirements of the poorer students have to be neglected by the teacher in order that the desires of what may be called the irregular pupils may be satisfied.

While discussing the matter recently with a sanitary inspector who had undertaken to instruct a class in his special branch of labour, the author asked him why he wasted his time on so many outsiders or amateurs, and the answer was that he had engaged to take the class, that he did not know that any and every applicant would be admitted to it, and that when he protested he was met with the argument that as every ratepayer contributed towards the erection and maintenance of the institution every ratepayer had the full right to avail himself of every opportunity of benefitting by any and every form of instruction which the institution was prepared to give. It is contended that no stretch of language can legitimately construe such an argument as being in accordance with the true principles of technical education.

There is another source of trouble and waste in our present system which may be called the overlapping or duplicating of classes. Owing to the present want of cohesion between the various schools, each school is worked as a separate entity and each school opens classes in as many subjects as it can find even a few pupils to attend, oblivious of the actual requirement of the vicinity, and of the work which is being done by neighbouring institutions. This is particularly the case in London. To take only one subject, that of electrical engineering; there is already more than sufficient machinery in the many London schools to provide for the requirements of the whole industry throughout the entire kingdom.

Enough it is thought has been said to show that in-so-far as what is herein considered to be the true objective of technical education is concerned, by far the larger portion of the money which is being spent upon so called technical classes, is absolutely wasted and often with pernicious results. But the leaks do not end here, for in many cases, cases which frequently come under our notice, the lecture rooms and laboratories are provided with quantities of costly apparatus which neither the teacher nor the student knows how to handle, and which is therefore damaged and ultimately destroyed by being kicked along the floor, or allowed to lie about until it falls to pieces.

What is the remedy for all this waste and mischief?

In the first place, the examiners should improve their papers, and make them such that only students practically acquainted with the various industries can answer them. Certificates should be withheld unless such a practical acquaintance can be proved. The questions should be framed in simple, accurate, and unmistakable phraseology.

Secondly, schools should be grouped together, each to specialize in one or two branches of industry, according to the requirements of the locality.

Thirdly, the teachers should be men actually engaged in responsible positions in the several industries.

Fourthly, the instruction should be arranged exclusively for men engaged in the several industries. Amateurs or outsiders should only be admitted on payment of a decidedly remunerative fee. Every *bonâ fide* student should be required to take courses of instruction in the science subjects allied to his particular technical subject. Let the fee for these students be an inclusive one to cover the allied subjects.

Fifthly, there should be an annual inspection and stock-taking of apparatus and materials, as a check, not against the actual stock, but in reality against the use which has been made of it.

It is believed that if a scheme similar to that which is now suggested were carried out, the various institutions would in a short time draw the right class of students, and in sufficient numbers to meet all requirements. The theoretical classes might be thrown open with certain restrictions to all comers. In this way the good that our technical institutions might accomplish is incalculable. The author would like to demonstrate this by showing what is being done in and by the school which he founded 21 years ago. None but telegraphists are admitted; nothing is taught but what is likely to be of service in the practice of telegraphy; every student is encouraged to take, in time, every class in the time-table. In the superior or third year classes, no student is allowed to enter unless he has attended successfully all the classes prescribed for first and second year students. We started with five students and now number 350. All the instructors were trained in the school, all were telegraphists and are still actively employed in the service, and all are medallists. The Postal Telegraph authorities are convinced that a technically trained telegraphist is more valuable than a simple manipulative telegraphist, because he is able to detect faults, and regulate his apparatus as required by the varying conditions of the lines, and the fluctuations of the traffic. And by a recently-issued order of the Postmaster-General, every telegraphist of 24 years of age and upwards, who is not already receiving his maximum scale of pay, and who can produce a certificate from the Science and Art Department and the City and Guilds Institute in Electricity and Telegraphy respectively, has £6 added to his salary every year until he attains his maximum. Last year no less than 19 of the students obtained superior appointments on account of their technical training, and such are a few of the results of technical education carried out on lines which this international Congress is asked to endorse as the correct and only true basis of technical education.

Mr. C. T. MILLIS thought the writer of the last paper did not intend to do injustice to any branch of the technical work which was being done in London, but as the paper had a general title—"The True Basis of Technical Education"—he felt, as one responsible for the education work of a polytechnic, he must call attention to one or two remarks made in connection with the attendance of apprentices at polytechnic institutions. He thought the writer of the paper really intended to refer more particularly to the teaching of electrical subjects, rather than to ordinary trade subjects, such as carpentry and plumbing. He would find that the majority of those attending the trade classes at the polytechnics were actually engaged in the industry for which the class was formed. The teachers of those classes were also themselves, in the majority of cases, actively engaged in the trade which they were engaged to teach, and they also had a knowledge of certain scientific principles which were cognate to the industry which they were teaching. He thought that none of the difficulties, and none of the mistakes mentioned in the paper, were made as regarded the technical education of workmen generally. They might possibly arise in electrical engineering, from the fact that students might attend classes in electricity and magnetism, those classes being open to all students, and then some might pass on to what might be called purely technical classes. He thought the reader of the paper had unwittingly done injustice to the London polytechnics. Mr. Wells had spoken on the difficulties which most principals of polytechnics experienced in procuring good teachers for the teaching of what might be called "trained classes," classes in such subjects as masonry, carpentry, plumbing, metal working, and engineering. He (the speaker) could quite understand that there might not be the same difficulty in finding teachers able to teach such subjects as electrical engineering. They were a more highly educated class of men, men who had received a certain amount of scientific training, and it might be easier to find teachers for those subjects.

Mr. A. E. BRISCOE said he should like to say a word about the last paper, especially as he had charge of the electrical department at Battersea. He thought Mr. Slingo had been rather unfair to the teaching carried on in the modern technical schools. They had to recognise the fact that they had two entirely distinct types of students to deal with; the artisan who was going to be an artisan merely, the man who would make a good skilled workman in his own branch, but who was never likely to do anything else; and there was also the man who had charge of jobs and who would rise to a more responsible position. Besides these two types, he had in some of his own classes men who wanted to get a knowledge of electrical engineering work in connection with their own trades; for instance, he had in a class at Battersea no less than three men who were fire insurance inspectors, and they joined the classes in order to get some knowledge of electrical work, especially some knowledge of what was to be avoided and what commended in the matter of wires. These different classes required entirely distinct types of instruction. The best thing to do for the artisan was to teach him his craft as well as we could. Give him a chance of doing things that otherwise he would not be able to do; give him a chance, too, of handling instruments, and seeing the inside of them, and of getting acquainted with them. Then, men in more responsible positions required a better training. They must be encouraged to take up work ontside their own work, and given the greatest variety of work to do. In that direction they hoped to do a great deal in the future. They hoped to get the boys who attended the technical day-schools to go on to technical work, and so be able to take up responsible positions. If they could in this way train up a body of men capable of doing the very best work they would not have existed in vain. He did not hold a brief for Mr. Wells, but he thought the point Mr. Wells was trying to emphasise was this—that you might find a man easily enough who knew his work thoroughly, but it was very difficult to find the workman who both knew his work thoroughly, and also possessed sufficient general knowledge to enable him to make a successful teacher. It might not, perhaps, be so difficult to find such a man in electrical engineering, because they were better trained than the average run of men.

Mr. CHARLES WILLIAMS (Northumberland) said he should not have troubled the Congress had not Mr. Slingo asked them to endorse his paper as indicating the only correct and true basis of technical education. What Mr. Slingo had described might possibly be the true system of technical education for telegraphists, but he was quite convinced that in the county he represented such an interpretation of technical education would not work. He could not conceive that any technical school in Northumberland was going to efficiently train an engineer, or a shipbuilder, or a miner, or even an agriculturalist, and he should like to enter his protest, and he hoped, with the approval of the Congress, against this limited definition of technical instruction being endorsed. He confessed he thought the reader of the paper was a little hard upon the outsider and the amateur, and particularly hard upon the institutions which he seemed to indicate preferred the outsider and the amateur to those who were engaged in the particular industries that the classes were established for. His own experience was in a contrary direction altogether. It seemed to him that if Mr. Slingo was going to ask them to spend public money for the exclusive benefit of a few particular industries or crafts, he would have to devise some means to enable them to meet the requirements of those useless outsiders and amateurs who apparently wished to do nothing except invade the classes where they were not wanted. He did not think that Mr. Slingo's inference was correct, that the gentleman who got the prize in telegraphy was the best trained telegraphist in the kingdom. He did not believe the certificate of the City and Guilds Institute declared anything of the kind. The certificate would only state that the candidate had passed a particular examination on the syllabus. He hoped that other members of the Congress, having in view what a very wide subject technical education was, would protest against the proposal that they should endorse Mr. Slingo's very limited definition.

Mr. T. TURNER said the first two speakers on Mr. Slingo's paper had spoken from the point of view of the polytechnics; the last speaker from the point of view of the country, and he, too, wished to speak from that point of view. Possibly, what Mr. Slingo said in his paper might have been correct five years ago, but it certainly did not fairly represent the position of technical instruction in the country now. In Staffordshire, for instance, they had a number of trade classes. They had a mining centre in North Stafford taught by a certificated mining engineer, one who had worked for a considerable time in a coal mine; in South Staffordshire they had a still larger centre for mining instruction taught by a properly qualified mining engineer, who had had to do with the management of a colliery; they had also a set of classes for the teaching of metallurgy, the teacher of which had for years been the chief chemist in the Yorkshire Iron Works, and in a Scotch Steel Works. All these classes were open to the general public, and yet, so far as he knew, there was not a single amateur attending any one of them. Mr. Slingo had also referred to the examiners under the City and Guilds of London Institute, and suggested that they had a difficulty in finding sufficient questions to set. He (the speaker) was one of those unfortunate people who had served his time as examiner under the City and Guilds Institute. Speaking from memory he believed he only had to set twenty questions each year, but he could easily have found a hundred on the subject of iron and steel manufacture; and he had no doubt the other examiners could have set an equally large number of questions on all the subjects with which the City and Guilds Institute had to deal.

Mr. E. PILLOW said he wished to support what Mr. Williams and Mr. Turner had said with regard to the limitations of technical education. It would be a great mistake to attempt to confine attendance at technical classes entirely to those persons directly engaged in a specific trade. Good apparatus and teaching power should be provided in the various institutions of those districts where special industries are carried on; the question of who shall be allowed to attend the classes will naturally regulate itself. In Crewe the superintendent and manager of the works always held out an inducement to their workmen to attend the classes and to make progress in the various subjects taught, especially the classes connected with iron and steel manufacture and mechanical engineering. Whenever classes were formed the London and North Western Railway Company provided money for good plant for the teacher's use, and men from the works who had distinguished themselves in the various branches were selected as teachers. Many of the pupils were afterwards selected to become foremen in the works, and they had always given very great satisfaction. In conclusion, Mr. Pillow gave several instances which had come under his own observation of men who had risen to fill responsible positions, mainly through the instruction they had received by attending technical classes.

The CHAIRMAN, in closing the Session, said he wished to congratulate the Congress on the very interesting discussion they had had. He was afraid Mr. Slingo would find himself in a minority with regard to the paragraph to which so much objection had been taken. He thought Mr. Slingo should have remembered at the same time that nobody could learn a subject thoroughly well without its being of some use to him. Supposing the amateur who passed an examination in carpentering was at the same time qualifying himself to become an architect. the extremely careful and technical, though merely theoretical, work which he had done in carpentering would always be of use to him. Therefore he thought we ought not to grudge the expenditure of a certain amount of money in theoretical education and the testing of the same by examinations. In the corps of engineers to which he belonged, they took a great many young carpenters, smiths, bricklayers, and tradesmen of all sorts and put them into a school at Chatham, and there they were taught, theoretically to a great extent, the other building trades, and after two years' instruction they left as most efficient foremen of works, able to look after, not only the particular trade in which they were brought up, but all the other trades connected with the building of a house. He hoped technical education would remove the blot from those industries in which, if a man's particular branch or work failed for any reason whatever, he was reduced to a state of poverty because he was unable to take up anything else.

THURSDAY MORNING, JUNE 17, 1897.

SECTION B.

Sir STEUART COLVIN BAYLEY, K.C.S.I., C.I.E., in the chair.

RAPPORT SUR L'ENSEIGNEMENT COMMERCIAL SUPERIEUR EN FRANCE.

PAR JACQUES SIEGFRIED,

Membre du comité permanent du Conseil Supérieure de l'Enseignment Technique, président de l'Union des Associations des anciens Elèves des Ecoles Supérieures de Commerce de France.

Messieurs,

L'idée de créer des écoles spéciales pour les jeunes gens qui se destinent à la carrière commerciale est relativement moderne. Cela provient en grande partie de ce que les connaissances nécessaires au négociant se sont bien étendues depuis que les chemins de fer, les bateaux à vapeur, le canal de Suez, les télégraphes, les téléphones et toutes les admirables découvertes scientifiques des temps présents ont pour ainsi dire supprimé les distances et rendu le commerce intérieur de chaque pays tributaire des fluctuations et des modifications de celui du monde entier.

Autrefois pour être un bon commerçant il suffisait d'avoir une instruction moyenne complétée par un stage dans les bureaux d'une maison s'occupant du genre de commerce auquel on se destinait. C'était ce que l'on appelait "faire son apprentissage." Aujourd'hui chacun de ces commerces exige que l'on connaisse non-seulement la comptabilité et les usages commerciaux français mais encore que l'on soit au courant de ce qui se passe à l'étranger, que l'on puisse lire ou même parler plusieurs langues, que l'on soit familiarisé avec les monnaies, poids et mesures usités dans les divers pays, que l'on sache faire des prix de revient, des arbitrages, que l'on ne soit point étranger aux questions financières et même, dans une certaine mesure aux différentes législations commerciales, enfin que l'on soit au courant des marchandises produites et des articles consommés par les diverses nations.

La nécessité de ces connaissances s'est encore accrue par suite de la transformation qui s'est faite dans l'industrie. Autrefois l'industriel devait viser surtout à la partie technique; l'écart entre les prix de la matière première et du produit fabriqué était assez considérable pour que le succès fût assuré quand on produisait de bonne marchandise à un prix de revient modéré. La fortune souriait surtout à ceux qui savaient trouver ou appliquer quelque perfectionnement nouveau dans la fabrication. Aujourd'hui l'outillage et les procédés sont sensiblement les mêmes chez tous les concurrents; l'écart entre la matière première et le produit manufacturé a en outre, considérablement diminué; le succès de l'industriel dépend donc beaucoup de la manière dont il sait acheter la matière première et vendre les produits de sa fabrication. Et un mot l'industrie devient de plus en plus commerciale.

Si nous jetons un coup d'œil rétrospectif sur la marche de la civilisation, nous reconnaissons que chacun de ses progrès a amené la création d'écoles spéciales nouvelles. Les Ecoles de Commerce ont eu leur tour. On a commencé par celles du degré élémentaire et du degré moyen et l'on est arrivé aux Ecoles Supérieures de Commerce.

L'objet de la communication que j'ai l'honneur de faire aujourd'hui devant le Congrès de Londres est relatif à ces dernières. Je ne dirai donc qu'un mot des enseignements du degré élémentaire et moyen et ce sera pour rappeler que c'est surtout en Allemagne qu'ils sont florissants et bien organisés. Nous avons toutefois en France d'excellents modèles d'école du degré moyen, de ce que l'on nomme officiellement chez nous des Ecoles pratiques de Commerce et d'Industrie, dans l'Ecole de Boulogne-sur-Mer, et dans l'Ecole Commerciale de l'Avenue Trudaine à Paris.

Quant à l'enseignement commercial supérieur, et tout en rendant hommage à l'excellent Institut de Commerce d'Anvers, j'espère ne pas encourir le reproche que l'on faisait autrefois aux Français de se croire plus avancés que les autres peuples (nos revers de 1870 nous ont obligés à devenir plus modestes) en osant dire que c'est en France que se trouvent en ce moment les meilleures Ecoles Supérieures de Commerce.

Nous en avons actuellement 11 et si nous voulons en faire l'historique nous devons avant tout rappeler le grand fait qui est venu, il y a quelques années, donner un nouvel essor à celles qui existaient déjà et provoquer de nouvelles creations. Je veux parler de la loi du 15 juillet, 1889, sur le recrutement de l'armée française et de son article 23 qui donne aux élèves diplômés des Ecoles supérieures de Commerce reconnues par l'Etat la faculté de faire seulement un an au lieu de trois années de service militaire.

Cette loi devait naturellement avoir pour effet d'accroître le nombre des élèves de ces Ecoles, mais elle avait aussi pour corollaire de leur imposer un programme, un concours d'entrée, une limitation du nombre de leurs élèves, enfin des examens de sortie devant des jurys nommés par l'Etat.

Celles de ces Ecoles qui avaient été fondées avant la loi de 1889 étaient dues surtout à l'initiative individuelle; depuis lors ce sont les chambres de commerce des différentes régions qui en ont crée et qui les administrent.

Toutes ces Ecoles ont le même but: préparer leurs élèves à devenir de futurs chefs ou principaux employés d'établissements commerciaux ou de maisons de banque, des directeurs de comptoirs à l'étranger, des agents consulaires capables de représenter dignement la France dans les relations du commerce international.

Depuis la loi de 1889 leurs programmes sont devenus sinon uniformes du moins assez semblables. Le fond en est le même, mais chaque école y ajoute des cours spéciaux plus particulièrement adaptés aux besoins de la région dans laquelle elle recrute ses élèves.

Elles n'admettent toutes que des jeunes gens d'au moins 16 ans, mais ils sont en général passablement plus âgés; il n'est pas rare d'y voir des élèves de 20 ans et au-delà. Ils sont en grande majorité externes. La durée des études est de deux ans, mais presque toutes les Ecoles y joignent une école préparatoire de un an.

Les cours occupent une moyenne de 33 heures par semaine; le reste du temps est employé par les élèves pour la rédaction de leurs notes.

La base de l'enseignement est ce qu'on pourrait appeler le bureau commercial; c'est la que pendant 10 à 11 heures par semaine on enseigne la comptabilité sous toutes ses formes, factures, comptes courants, journal, grand-livre, bilans, monnaies, poids et mesures des différents pays, calculs de prix de revient, arbitrages, de change et de valeurs, etc., etc.

La géographie économique et commerciale occupe 3 heures par semaine; ou y passe en revue les ports et grands centres commerciaux ou industriels, les productions, importations, exportations, de chaque pays et de ses colonies, les voies de communication, etc., etc. Comme corollaire à ce cours on consacre environ une heure par semaine à l'histoire du commerce.

Un cours de marchandises de 3 heures par semaine fait passer sous les yeux des élèves les principaux produits, les met à même de reconnaître les conditions qui en déterminent la valeur, les renseigne sur le commerce auquel ils donnent lieu, etc., etc.

On consacre 2 heures par semaine à la Législation commerciale, maritime et industrielle et une heure à la législation ouvrière, fiscale, douanière et à l'économie politique.

La calligraphie n'est pas négligée et occupe de une à deux heures par semaine.

Les langues vivantes sont considérées comme une des bases de cet enseignement; l'anglais y est obligatoire et prend 4 heures par semaine, une seconde langue occupe aussi 4 heures par semaine consacrées, aux choix des élèves, soit à l'allemand, soit à l'espagnol, l'italien ou même l'arabe.

Enfin, chaque Ecole, suivant les besoins de la région dans laquelle elle se trouve, accorde 2 ou 3 heures à des cours spéciaux, tels que l'armement, l'étude des transports, la microscopie, la technologie, la sténographie.

Tel est dans son ensemble le programme des Ecoles Supérieures de Commerce de France; il à donné jusqu'ici toute satisfaction.

Il me reste maintenant, Messieurs, à vous donner les noms et à vous présenter un historique, aussi abrégé que possible de nos Ecoles.

La plus ancienne est l'Ecole Supérieure de Commerce de Paris. Elle a été fondée en 1820 par deux négociants parisiens, Messieurs Brodard et Legret, fut dirigée de 1830 à 1854 par Adolphe Blanqui et a pour directeur depuis une quinzaine d'années Mons. Grelley. Un de ses professeurs les plus distingués a été pendant de nombreuses années Mons. Joseph Garnier que beaucoup d'entre vous ont certainement connu.

La Chambre de Commerce de Paris à laquelle elle appartient depuis 1869 et qui l'administre au moyen d'un Comité pris parmi ses membres, va consacrer une somme de un million et demi de francs à l'agrandir considérablement, et la Ville de Paris vient de lui allouer une subvention de 600,000 francs. L'Ecole ne reçoit que des internes et des demi pensionnaires; le prix annuel est de 2,000 francs pour les premiers, de 1,000 francs pour les derniers. Il est annexé à l'Ecole un cours préparatoire de une année. Le nombre des places mises au concours pour les examens d'entrée de cette année-ci est de 60, ce qui montre que l'Ecole a environ 120 élèves, non compris ceux du cours préparatoire.

Depuis sa création cette Ecole a vu passer sur ses bancs environ 7,000 élèves dont un grand nombre occupent aujourd'hui des positions importantes dans le commerce et l'industrie. Le programme des études se distingue de celui que j'ai décrit plus haut par une plus grande subdivision qui permet de spécialiser les mathématiques, la géométrie, la chimie et d'adjoindre des cours de technologie, de mécanique, de sténographie, et de dessin linéaire. Pour accomplir tout ce programme il a fallu porter à 36 heures par semaine le nombre des classes.

La seconde Ecole créée en France a été celle de Mulhouse fondée en 1866 par la Société Industrielle sur l'initiative de deux de ses membres. Cette Ecole dirigée par

Mons. Achille Penot et dont les programmes ont servi de modèle à toutes celles qui ont été fondées ensuite fut malheureusement obligée de fermer ses portes à la suite de la guerre de 1870, le gouvernement allemand voulant exiger que ses cours se fissent en langue allemande. Son corps enseignant se transporta à Lyon qui s'occupait précisément, à ce moment-là de fonder une Ecole.

L'Ecole Supérieure de Commerce du Hâvre s'est ouverte en 1871 ; elle a été fondée par un groupe de négociants réunis en société par actions au capital de 220,000 francs, et elle a été cédée ensuite à la Chambre de Commerce qui l'administre actuellement. Elle ne reçoit que des élèves externes moyennant 600 francs par an pour ses cours normaux et 400 francs pour son cours préparatoire. Son Directeur est Mons. Dany. Le nombre des places mises au concours pour les examens d'entrée de cette année-ci est de 40. Un seul cours est ajouté au programme général, c'est une heure par semaine d'armement.

L'Ecole Supérieure de Commerce de Rouen s'est aussi ouverte en 1871, fondée par la Société Civile pour le Développement en Normandie de l'Enseignement Industriel et Commercial au capital de 250,000 francs. Elle a été réorganisée l'année dernière et mise sur un excellent pied par la Municipalité de Rouen. Elle reçoit des externes payant 600 francs, des internes payant 2,400 francs et des demi pensionnaires payant 1,050 francs. Elle a un cours préparatoire. Son Directeur est Mons. Malepeyre. Le nombre des places mises au concours pour cette année-ci est de 35. C'est l'Ecole de Rouen qui a eu l'honneur d'inaugurer les cours de microscopie commerciale et de tarifs de chemins de fer.

L'Ecole Supérieure de Commerce de Lyon a été fondée en 1872 sous forme d'une société par actions au capital de 1,120,000 francs. Elle est placée sous le patronage de la Chambre de Commerce et administrée par un Conseil composé de 13 membres. Elle ne reçoit que des externes à raison de 600 francs par an pour ses cours normaux et de 500 francs pour son année préparatoire. Son Directeur est Mons. Saint-Cyr Penot, fils de l'ancien Directeur de l'Ecole de Mulhouse. Le nombre des places mises au concours pour les examens d'entrée de cette année-ci est de 80. A leur entrée à l'Ecole les élèves sont groupés en trois sections suivant qu'ils se destinent : 1° à la banque ou au commerce général ; 2° au commerce spécial des soieries ; 3° au commerce des matières tinctoriales et des produits chimiques.

L'Ecole Supérieure de Commerce de Marseille a été ouverte en 1872 sous le patronage de la Chambre de Commerce. Elle est un externat et la rétribution de ses cours est de 600 francs par an pour l'enseignement normal et de 400 francs pour l'année préparatoire. Les élèves peuvent prendre leur repas de midi à l'Ecole moyennant 40 francs par mois. Son Directeur est Mons. Lejeune, ancien élève de l'Ecole de Mulhouse. Le nombre des places mises au concours pour l'année 1897 est de 65. L'Ecole de Marseille se distingue par des cours de langue arabe et de langue grecque et par des conférences dans lesquelles les élèves ont à traiter, à tour de rôle, en présence de leurs camarades, diverses questions de comptabilité, de géographie commerciale, de marchandises, de législation ou d'économie politique. Il leur est interdit de lire leur travail, mais ils ont le droit de se servir de notes. L'Ecole de Marseille a aussi une section de la Marine marchande pour les aspirants au grade de Capitaine de la Marine marchande.

L'Ecole Supérieure de Commerce et d'Industrie de Bordeaux s'est ouverte en 1874 sous la direction de la Société Philomathique, avec le patronage et le concours du Conseil Général, de la Ville et de la Chambre de Commerce. Son Directeur est Mons. Manès. Elle ne reçoit que des externes au prix de 400 francs par an pour les cours normaux et de 200 francs pour le cours préparatoire. Le nombre de places mises au concours pour l'année 1897 est de 60. C'est à Bordeaux et sous l'impulsion de la Société Philomathique que se sont tenus en 1886 et en 1895 les deux Congrès internationaux de l'Enseignement technique qui ont été si remarquables et ont tellement contribué au développement et à l'amélioration de l'Enseignement commercial.

La plus importante, la plus richement dotée des Ecoles de Commerce est l'Ecole des Hautes Etudes Commerciales de Paris, conçue par Mons. Gustave Roy, Président à cette époque de la Chambre de Commerce de Paris et ouverte en 1881. Cette Chambre y a consacré deux millions de francs. Elle est administrée par un Comité de membres de la Chambre de Commerce et a pour Directeur Mons. Jourdan. On y reçoit des internes payant 2,200 francs, des demi pensionnaires à 1,300 francs et des externes a 1,000 francs pour les cours normaux, et 2,200, 1,300 et 1,000 frs. pour le cours préparatoire. Le nombre des places mises au concours pour les examens d'entrée de 1897 est de 135.

L'Ecole a eu l'excellente idée de publier une statistique indiquant les situations occupées en ce moment par les élèves qui on suivi ses cours de 1881 à 1895. Ils ont été au nombre de 1,150 sur lesquels 461 sont dans le commerce, 506 dans l'industrie, 36 dans la banque, les assurances ou les chemins de fer, 8 dans le Professorat commercial, 35 dans les consulats, chancelleries ou ministères, 3 sont sans profession et 21 sont décédés ou perdus de vue. Cette statistique est certainement le plus bel éloge que l'on puisse faire de l'enseignement commercial en général et de l'Ecole des Hautes Etudes en particulier.

L'Institut Commercial de Paris date de 1884. Il a été fondée par un groupe de négociants parisiens désireux de diriger les jeunes gens vers le commerce d'exportation. Son Directeur est Mons. Bernardini, ancien professeur à Mulhouse. Le nombre des places mises au concours pour les examens d'entrée de cette année est de 45.

L'Ecole Supérieure de Commerce de Lille et de la Région du Nord a été reconnue par l'Etat par décret du 12 juillet 1892. Elle est placée sous le patronage des Chambres de Commerce de Lille et des villes environnantes. Son Directeur est Mons. Trannin. Elle ne reçoit que des externes au prix de 700 francs par an, tant pour les cours normaux que pour l'année préparatoire. Le nombre des places mises au concours pour les examens d'entrée de cette année est de 45.

Enfin Nancy vient d'ouvrir sous la direction de Mons. Lapointe, et Montpellier se prépare à fonder sous la direction de Mons. Cantagrel des Ecoles Supérieures de Commerce qui, profitant de l'expérience de leurs devancières, seront dignes, je n'en doute pas, de la haute mission qu'elles se proposent.

Tel est, Messieurs, l'état actuel de l'enseignement commercial supérieur en France. Si j'ajoute que l'Etat lui est absolument favorable et qu'outre la faveur du service militaire d'un an, il accorde à nos Ecoles Supérieures des facilités pour l'entrée dans les carrières diplomatique et consulaire, dans les chancelleries, dans l'Administration des Douanes, dans l'Ecole Coloniale et met libéralement à leur disposition des Bourses de voyages et de séjour à l'étranger; si je rappelle que chacune des Ecoles a son Association Amicale de ses anciens élèves et qu'enfin ces différentes associations se sont groupées en une importante Union des Associations des anciens Elèves des Ecoles Supérieures de Commerce reconnues par l'Etat, je crois qu'il me sera permis de terminer en disant que l'Enseignement Commercial Supérieur de France mérite l'attention des personnes distinguées qui se sont réunies pour former le Congrès de Londres.

SUGGESTIONS ON COMMERCIAL EDUCATION.

By H. W. Eve, M.A.

Headmaster of University College School, Dean of the College of Preceptors.

Some years ago the London Chamber of Commerce, in connection with several persons experienced in education, drew up a somewhat elaborate curriculum for commercial education based mainly on foreign models, and instituted an examination with a good many money prizes for lads of 16 and 17 about to enter business. A similar examination was for several years carried on by the University of Oxford. There is no doubt that these efforts have done something to raise the standard over a limited field, but it may be questioned whether they have entirely answered the object of their promoters in recruiting the ranks of commerce with a body of highly educated young men, and supplying such young men with the *carrière ouverte aux talents*.

It may be that a first-rate general education is not a factor, or is only an insignificant factor, in producing a good man of business; it may be that, as some think, it is best for a lad to go into an office as soon as he can write a decent hand and add up a column of figures, and to be set to work to stamp letters and run errands. If so, I am afraid it is superfluous for a schoolmaster to take up your time. But I gather that a different view prevails among enlightened men of business; that making due allowance for the many qualities that tell in a commercial career, they do believe that a good general education is an important element in business as it is admitted to be in the army, in the legal and medical profession, and the higher branches of the Civil Service. In several lines of business, such as that of an actuary, a patent agent, or a chartered accountant, both a preliminary and a specia examination are required, and several banks exact some test—not, it is true, a very high one—of general attainment. That an examination test of any severity should be applied to ordinary clerks, is probably out of the question the work is too dull, and the pay and prospects too small to be tempting to the highly educated But among the lads who crowd into overstocked professions, or are sent to the univer

sity at a considerable sacrifice, only to find themselves stranded at 22, there is a large amount of good material which might be utilised for the development of the commerce of the country, if a more attractive career were opened to them. At present, private connection apart, there is an effectual demand in business for intelligent lads of 15 or 16, and next to none for those of 18 or 19. We want, in fact, an effective machinery for bringing more of the educated ability of the country into the higher walks of business. The Chamber of Commerce plan seems to me to fall between two stools. It implies an education—and that partly technical—completed about 16, and not rising far above the standard of an ordinary clerk; it does not reach the standard of a good professional student. The best educated men of business, including men of university distinction, have, as a rule, started some way up the ladder in virtue of private connection and influence. There seems no adequate reason why the number of such men should not be increased, and why they should not be drawn from a wider field.

One obvious method suggests itself—the method which has done so much to raise the standard of the army and the higher branches of the Civil Service at home and in India. Why should not great firms combine to offer at any rate a small number of good posts on an examination based upon the ordinary curriculum of schools, to lads of 18 or 19, giving a large choice of subjects, and making none of them compulsory, except arithmetic, a modern language, and English composition? The selected candidates should be required, a few months after this examination, to pass in book-keeping, and perhaps in shorthand. They should then be taken into offices and placed in positions where they would have the opportunity of learning, and be exempted as much as possible from the drudgery of ordinary clerks. They should, in fact, do no more mere clerical work than is sufficient to enable them to direct others. An engineer works in shops not in order to become a workman, but in order to become a director of workmen, and the training of men for the higher walks of business might, it seems reasonable to believe, follow analogous lines.

But while I should hold that any good general education would be sufficient, it is not unnatural to prefer the curriculum of the modern rather than that of the classical side of schools. I will proceed, then, to sketch in some detail the line of education which seem best adapted for lads leaving school at 18, and intended to be officers rather than privates in the army of commerce, premising, of course, that something must be conceded to individual taste and that a study pursued *con amore* is generally the most effective mental discipline. On the whole, the literary, rather than the scientific, elements should predominate in their education, just as mathematics and physical science predominate in the training of an engineer. In the higher walks of business, men have to deal with economic problems, with political conditions, with questions approaching as near to law as a layman dare venture, and with that general knowledge of foreign countries which is necessary to anyone who is anxious to extend his operations. For all these purposes, width of reading and the power of collecting facts and drawing inferences from rather extensive materials is necessary—probably more necessary than the rigorous methods of physical science. Add to this, that in some form or other a knowledge of some foreign languages and facility in acquiring others is in most cases essential.

Classics should take quite a subordinate place. Clever boys generally begin Latin early, and by 14 or 15 have learnt enough to profit by its mental discipline, and to make the acquirement of other languages comparatively easy. Moreover, the difference between the classical knowledge of an intelligent boy of 14 and a matriculation or "little-go" standard is often hardly worth the time spent on it. On the other hand, it is possible between 14 and 18 to gain a knowledge of at least two modern languages, combining practical utility with intellectual discipline of a high order. It is possible, too, within those limits to read widely enough to lay the foundation of a taste for literature, an object which is seldom attained by a classical education cut prematurely short.

The selection of languages is rather a difficult problem. A gentleman who has given a great deal of thought to commercial education, Mr. Hooper, has gone so far as to suggest that different schools should make a speciality of different languages; Spanish, for instance, being taken in one, Russian in another, and so on. The two languages most studied, French and German, are by no means the only ones useful for commercial purposes, perhaps not the most useful for the extension of commerce. On the other hand, the educational machinery in the way both of books and of competent teachers is far better in the case of those languages than of any others.

To teach any language efficiently, you require, at least, four successive classes, and, therefore, some 50 or 60 boys in a school studying that language. As a matter of practice, the boys of an average school studying French fall into a dozen classes, those studying German, which is generally begun later, into quite half-a-dozen. There is, then, much to be done before any other language can be successfully introduced as a school subject. Even French and German teaching is, in many schools, less systematically organised than that of Latin and Greek.

Next, a word or two as to method. There have always been two opposite views as to teaching modern languages. With one set of teachers, fluency; with the other, accuracy has been the main object. There is a growing conviction that the one ought to be done, and the other not left undone. It is recognised that a modern language can hardly be said to be known, when a candidate for examination cannot pronounce properly, write readily and correctly from dictation, and answer simple questions in the language. On the other hand, it is a common complaint that children who have had early opportunities of talking a language, without systematic grammar training, are very apt to fail, both in writing it correctly, and in translating from it into English with anything like accuracy.

It is awkward, for example, to miss entirely the meaning of a German sentence from ignorance of the subtleties associated with particles like *doch*, *schon*, and so on. Even translators of considerable general attainments come to grief occasionally for want of accurate scholarship. I see no reason for neglecting the conversational side, but it should be subordinated to that habit of accurate translation both from and into a foreign language, which is essential both for mental discipline and for real mastery of it. As to reading, let us have literary masterpieces as soon as a boy can understand them, and let an effort be made to read some books rapidly while others are studied with the minutest care. Commercial correspondence is nearly as much out of place at school as the technicalities of legal documents. A boy who can turn Lessing's Laocoon into good English, and a passage of Macaulay into passable German, will not take long to learn how to "apologise for delay in the execution of your esteemed order."

Perhaps I have spent too much time on modern languages, but I look upon them as the backbone of the type of education I am sketching. Briefly, I would have a boy up to about 14 trained, as far as language is concerned, on Latin, French, and the elements of German. He should then drop Latin, make either French or German his *pièce de résistance*, and set systematically to work at an additional language. The other parts of the curriculum may be more briefly dealt with.

English should, of course, have an important place. Composition must be practised, and a little time may well be found for précis-writing, which teaches the habit of getting clear information out of a mass of details, and of putting it into shape And the more English literature the better, and that not only for the reasons given above, but for the sake of keeping in touch with the educated world, and as an antidote to meaner tastes, including the silliest and most vulgar of them all, that for betting on horse-races, which is not unknown in the city.

Arithmetic is an absolute essential, and should have more time given to its higher parts than is ordinarily the case. It is surprising how few people, for example, really think in decimals. They are not indeed as bad as a well-known Chancellor of the Exchequer to whom the meaning of certain dots (I believe he qualified them by an un-Parliamentary epithet) was a revelation, but while most of us understand ·5, many educated people do not at once realise the meaning of ·875. Indeed to think at all in numbers is a difficult and by no means too common accomplishment. Even in my own profession, I have met with intelligent men to whom the assignment of marks of boys' work was always more or less of a mystery. In mathematics, I see no reason for going very far, except in the case of special aptitude. In science, I should be disposed to prefer the elements of botany and geology to those of physics or chemistry. Time is a consideration, and not only are botanical and geological facts of more direct value to a man of business, but the methods of reasoning of these sciences seem to have more analogy with their future work. Recent examinations for commercial certificates make a strong point of commercial geography. The proper treatment of this subject is a question rather of method than of actual range of knowledge. To understand trade routes and the capabilities of different countries means a considerable acquaintance with what the Germans call *Erdkunde*; and, thanks to the efforts of the Royal Geographical Society and the Geographical Association, much progress is being made in this direction. But it ought not to be forgotten that familiarity with the names and positions of places, which some advanced geographers are apt to look down upon, is a kind of information by no means to be despised. Lastly, the elements of political economy are absolutely essential, and the subject is one which lends itself extremely well to school teaching in the higher classes. Many of the problems are quite within the range of boys, and there is no better exercise in English composition than the answering of simple economic questions. It is a study, too, for the continuation of which special facilities are offered by the Economic Institute. Commercial history, it would seem, should be combined with political economy. It is the surest way of eliminating details of antiquarian rather than practical interest, such as are apt to find their way into a text-book written exclusively from the point of view of commercial history.

In conclusion, I would hope that such a curriculum as I have sketched is not beyond the powers of schools to carry out, nor likely seriously to interfere with their natural routine. But I cannot say with Alceste, "Le temps ne fait rien à l'affaire." In point neither of quantity nor of quality is it adapted for boys who leave school before 18, and to attract clever boys of 18 adequate inducements must be offered.

COMMERCIAL EDUCATION AND THE NEED FOR A SCHOOL OF COMMERCE.

By Dr. Richard Wormell, M.A.
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It is well that commercial education has a distinct mention in this Conference. We have in the last few years done much to clear up the relationship and co-ordination of special kinds of education needed by different sections of the community. The definitions contained in the Report of the Royal Commission on Secondary Education led to the inclusion of technical education in secondary and commercial education in technical.

As regards secondary education the report says:—"It is the education of the boy or girl not simply as a human being who needs to be instructed in the mere rudiments of knowledge, but it is a process of intellectual training and personal discipline conducted with special regard to the profession or trade to be followed."

In this definition the education of professional men and women, and also that of men and women engaged in commerce are both included. Now, in commerce, there are two sections of operators: there are the producers and the distributors of the world's goods. Some technical educationists have perhaps been exclusively looking at the educational wants of the producers. The two sides have an equal right to be considered, and each has a special right to be heard as regards its own special needs. The questions proposed by either side do not involve the imposition of the same kind of education on all members of the community; on the contrary, they emphasise the necessity for providing for individual and special wants.

The movement for technical education was intended, in the first place, to stimulate the producing powers of the community, and, similarly, the movement for commercial education is intended to assist the distributing classes, consisting of merchants, clerks, warehousemen, travellers, buyers and sellers, actuaries and bankers, by causing a corresponding improvement in the education of those who are destined for a mercantile career.

Now there are so many considerations common to both sides of the question that I prefer to include both as kinds of technical education. In regard to both sections—the technical education of the producers, and the technical education of the distributors—there are two points to be distinguished. The first involves the question, "How can the schools assist the needs of these classes by the work which is antecedent to the period of specialisation?" The other involves the question, "What provision should be made for the study and training which follow the selection of employment, and consequent specialisation?"

It was long ago settled that there are two stages in education more or less overlapping, and yet distinct—one aiming chiefly at the development of faculty, the other at its application. There is the making of the man, and there is the making of the man into a merchant, a fabricator, a worker of some sort. There is first the awakening of intelligence and forming of character, and then there is the acquiring of the knowledge and skill in matters specially pertaining to business. Now, when trades were less complex and businesses were small, the two conditions of success were sought one after the other—the first at school, the second in business, the good master teaching his good apprentice the secrets and intricacies of his craft. The subdivision of labour and the aggregation of businesses into great concerns, together with their complication by the introduction of scientific machinery, made the old modes of training for business well nigh impossible. The apprenticeship system decayed. The great movement to which I am referring arose in search of a substitute. Some have supposed that the change can be met by the schools. This is an error. The two stages of education cannot be welded, cannot be reversed. In the search for a substitute for the second, it was, however, fairly asked of the schools that they should take up a little of the special work, such as might consist of the choice of the more useful subjects when alternatives were offered between subjects similar in character and equally effective as mental discipline. But the danger of specialising too soon is a conviction from experience in the case of schoolmasters. We believe it would be disastrous as regards education if we were to yield to any pressure to encourage specialising in schools. When the schools have contributed all they can towards meeting the demands of modern times, there will still remain the need of a substitute for apprenticeship. The drapers, the mercers, brokers of all sorts—even actuaries, and the bankers, too—had their articled pupils or apprentices, and in this section of trade as well as in the other the apprenticeship system has declined The technical and commercial movements spring from the same cause and are of the same nature. They have a common *raison d'être* in the limitations that necessarily attach to the aims of the schools and the necessity for an education beyond these limitations. The schools lay the common foundation.

Take all the demands made upon us by all employers and directors, merchants, manufacturers, engineers, professionial men and statesmen, select from them the part which is common, and you find it consists of a demand for intelligence, wisdom, sagacity, soundness of judgment, clearness of perception and common sense, and these are the products of a sound and broad general education. We may perhaps add what was said by the almost forgotten Andrew Yarranton, nearly two centuries ago:—"Common honesty is as needful in kingdoms and commonwealths that depend on trade, as discipline is in an army; and where there is want of common honesty in a kingdom or commonwealth, from thence trade shall depart. As the hon , honesty, riches and strength of nations are, so will be their trade. These are five sisters that go hand-in-hand, and must not be separated." Hence, honour, honesty and strength of character are the first things to be sought for, and these are to be developed in the schools. That trade-knowledge, which must be added to them to produce success, is not a matter for the schools. The chief special need is found by those who, having selected their occupations find there are special subjects in which they require the help formerly given to apprentices. These do not so much need stimulus as an opportunity. They should in this great city be able to get the best possible teaching for a very small cash outlay on their own part. For the higher and most special of the special training there ought to be a commercial institute, independent of any college or university. It is advisable that those who would seek the aid of such an institute shall find in it other students who are on the same kind of expedition, so that their attention may not be diverted or their enthusiasm cooled.

Long since I pointed out that we need here neither examinations nor examinees, but teachers and learners, and a temple of commerce, where these two classes will be brought into contact. Much energy and some wealth have been spent in the movement for commercial education, but only one small item of permanent provision has been secured, namely, the new School of Economics, of the London County Council. This is, however, but a small approach to the realisation of a sufficient scheme. It should be supplemented by a complete School of Commerce the work of which should treat of every function used in the production and distribution of wealth. Such a school is wanted for individual help. Those who would go to it would not require many subjects and yet the whole demand would be very varied. Each comer should be allowed to pursue only the knowledge he or she individually seeks, and should be helped to it in the shortest possible time under the best possible guidance, and at the least possible monetary cost to himself. He should find there a way to get into contact with those men of business who have the best knowledge of the things, or processes, or methods he wishes to learn. Hence, in addition to a permanent staff the school of commerce should be able to call to its aid for periods long or short, as the case requires, the highest skill, the widest experience, the best business capacity. This plan of securing professional aid from outside the ordinary teaching profession is well known in France. For instance, I found at the College at Saint Cloud that space was provided in the time-tables for lectures and conversations by leading writers, workers, and thinkers of Paris, some being engaged in literature, others being members of the Chamber of Deputies. Such a plan would be a necessity of the school of commerce or commercial institute.

The commercial institute should be placed where the clamour and pressure of business put themselves in evidence, where the atmosphere is full of them. Universities and university colleges fortunately have another atmosphere. In them very different influences address the young, and combine in moulding character and sentiment. In them the student's surroundings speak to him with the voices of many ages. They speak not only of the present, but they also attest the continuous life and greatness of his country, and the magnanimous liberality of England's ancestors. Who would wish to convert the university colleges into commercial institutes if it were possible to do so. It is, however, not possible.

Yet in the throngs of trade there seems to be needed a place where the best information and the best trade methods can be obtained; where any kind or system of book-keeping for any kind of complication whatever can be learnt; where he who wants Spanish or Russian or any other speech can get it taught him at a small cost by the best teachers; where commercial law or commercial lore of any kind can be provided without stint; where he who simply wants to know how to do this, that, and the other, can be introduced to him who has already found it out; and, most important of all, where those merchants who are prepared to pay the price can find an employee with all the qualifications they may require.

Mr. G. H. RENDALL (Principal, University College, Liverpool) said it might be useful to cite some of his experience of the difficulties which beset the development of commercial education, both in schools and colleges. He was not sure that the university college was not a more hopeful organ of higher commercial education, at any rate, than the school. Mr. Eve had given them a striking and valuable paper upon an ideal system of commercial education in schools, and the main factor that he brought into consideration was the question of age. He had said that for boys of 14, 15, or 16 years of age there was an effective demand, but that for boys of 18 there was practically none. That was the real difficulty of the whole problem. The same thing was true of Liverpool schools, and their experience was corroborated by the university college. From the best schools there was any quantity of demand for boys up to 15 years of age. The leaders of commerce distinctly preferred, indeed, almost insisted, that the school-leaving age should not be above 15, or at the outside 16; and in the offices of merchants the boys who obtained places carrying the promise of promotion to the positions of trust and profit were nephews, or cousins, or sons of one of the partners in the firm; these boys obtained places by means of this influence, which would be denied to those of superior training coming from school at the age of 17 or 18. It was a most difficult matter in large banks, insurance offices, merchants' offices, and the like, to give precedence on the gronnd of superior training. He knew men in Liverpool who were warmly interested in educational matters, who had shown the most hearty goodwill in the cause by contributions in the form of money, by interest in the form of advocacy, and by favour shown to those clerks who were educating themselves, who yet found it almost impossible to reduce the term of apprenticeship in favour of those who came with some testamur from school or college. That was the great difficulty for students in schools. The modern commercial man, who was really interested in commercial education, when he came upon the educational platform, threw the emphasis continually upon good writing, shorthand, and on cyphering, and they could not have a higher education that limited its basis to good writing, shorthand, and arithmetic. He was not speaking of the Philistine, but of men interested in education who, instinctively and intuitively, threw the whole emphasis upon the importance of those mechanical arts. More and more business was tending to centre itself in the hands of the business director, who sat at his desk with his speaking tubes and telephones, and dictated to his shorthand clerks, and expected purely mechanical assistance—not relying upon the intelligence of his clerk, as the statesman did upon his private secretary, by saying "Answer this letter in that sense," but rapidly dictating it to his clerk, and having it taken down word for word. They had tried to develop commercial science in connection with the university college, and for this reason—that just those subjects upon which Mr. Eve had dwelt were not taught at the schools, and it was hardly possible to get competent teachers for them. He did not allude mainly to modern languages, for in that department it was fairly easy to secure competent teachers, both in regard to pronunciation and grammar. But when they came to commercial law, and history, and political economy, it was almost impossible, amongst ordinary schoolmasters, to find one who had made a study of these subjects, and proper text-books were almost entirely lacking. Therefore, it seemed fairly well worth while, as they had a professor, charged with subjects ranging over political economy, commercial geography and history, to develop that side of the curriculum. The success had been extremely small, and what it practically resolved itself into was two or three youths, out of a very large community, taking their two or three year courses of the business curriculum. The large banks and institutions all promised support, but the nett result was the entry of two or three students annually, who were almost invariably the sons of men in business—not young men who hoped to get places on their merits, but sons of men who, being heads of business firms, wished their sons to take an intelligent interest in the subjects to which their lives would be devoted. In that respect they had got a fair response, but, of course, that was not the kind of thing which Mr. Eve was looking for.

M. E. SÈVE referred to his paper read on the previous day in Section A, as that dealt with commercial as well as technical instruction, and explained his views on this subject as taught in Belgium.

M. ALBERT BRETON (Paris) said he wished to make a few remarks on the report of M. Jacques Siegfried. He was not a professor, but he was very well acquainted with commercial and technical education as pursued in France. He had been a pupil for five years in the elementary and superior schools, and if he could not give his experience as a professor, perhaps they would allow him to give his experience as a pupil in those schools. Among the superior schools in France L'Ecole des Hautes Etudes Commerciales —which was created by the Paris Chamber of Commerce, and was to represent the highest degree of commercial education, as stated by the President, Mr. G. Roy. According to this gentleman, there were three degrees of commercial education—1, the elementary degree; 2, the superior degree; 3, the high degree. It had for its object the reception of scholars who had completed their classical studies, and were Bacheliers ès Sciences or Bacheliers ès Lettres. It was recognised that it was useless to expect a boy of 13 years of age to train himself specially for a certain trade or profession, whereas at 16 years of age he might reasonably be expected to have predilections which he could cultivate. But, for a long time, the commercial profession was not held in very high esteem, with very few exceptions, on the Continent. Therefore, the Paris Chamber of Commerce wanted to give an opportunity to the young men who wished to devote themselves to commerce, and principally to the sons of their merchants, among whom very few used to follow their fathers. It was with that object that the Ecole des Hautes Etudes Commerciales was provided in Paris in 1881. Its intention was to make the same difference between other superior commercial schools and that school as existed to-day in France between les Ecoles des Arts et Metiers, and l'Ecole Centrale des Arts et Manufactures. The pupils received excellent instruction, which proved its value when they had left school, and to-day the Chief of the Commercial Education Bureau in the Ministry of Commerce was an old pupil of that school. Since the passing of the law of 1889 the tendency had been to affiliate every other commercial school with the Ecole des Hautes Etudes Commerciales, so that the law which had done so much good for the pupils themselves had done great harm to the Ecole des Hautes Etudes Commerciales. The establishment of a third year at the Ecole des Hautes Etudes Commerciales was spoken of at the late International Congress at Bordeaux, and the suggestion was supported by some professors. This measure seems unnecessary, for it should be remembered that, if they devoted two years to commercial education—which was an excellent thing—they lost two years of commercial practice, and two years of commercial education ought to be enough to make a good merchant.

COMMERCIAL EDUCATION IN ENGLAND AND AMERICA.

By BERNARD DE BEAR.
Principal, Pitman Metropolitan School.

In preparing this paper, one of the main objects has been to endeavour, as far as possible, to remove the extraordinary misconception that exists in the public mind, as to business training institutions and their methods in this country. Quite recently I was present at a debate on "Commercial Education," which took place under the auspices of the London Chamber of Commerce. One of the principal speakers at that discussion was a prominent member of the London County Council, one indeed, whose special energies have been directed to the subject of education in various forms, and I was astounded to hear from his lips the utterance that "commercial business colleges were practically non-existent in this country, or in other words, that no gentleman would care to send his children to such as were established." It is with the object of combating such injurious and reckless statements as these, that I have brought together a few facts in order to show what is being done for commercial education in this country by private enterprise and energy alone, and that despite the sneers of those who should be its well wishers, if not its supporters.

As to the statement I have quoted, I will content myself by saying that it is absolutely untrue. The institution with which I have the honour to be connected is the parent institution of the kind in this country, and has been in existence for twenty-seven years, in the course of which it has received as pupils members of the highest families in the land, representatives of all the learned and honourable professions, and, in short, a patronage of as good status and social position as that bestowed upon any of the best public schools in the kingdom.

In the spring of 1895, I paid a visit to the United States, with the object of inquiring into the methods of business training in America. I visited over twenty of the best business training colleges on the other side of the Atlantic, in such cities as New York, Philadelphia, Washington, St. Louis, Chicago, Detroit, Cleveland, Albany, and Boston. In the States, at any rate, I found that students at these colleges were drawn from the very best families in the country, and though it is inevitable that the class of student at a business college, whether in England or America, should be a mixed one, yet it is a fact that the large majority of the pupils represent what we call "the middle and upper classes." These institutions play an extremely important part in the business life of the United States, for not only is a finishing course in business considered a fitting termination to the young American's educational career, but the majority of the business houses in the different cities of the States depend upon these colleges for the supply of assistants to be engaged either as book-keepers, stenographers, typists, or in any other capacity.

As a rule, the American business college insists upon its students taking up a complete course of study as mapped out in its prospectus; unlike the method adopted in this country, as I shall presently show. The fees for tuition average about $35 to $40 per term of ten weeks, or $100 per year; say, £20 of English money.

The commercial course of study comprises book-keeping—single and double entry—commercial arithmetic, penmanship, commercial law, business correspondence, business forms and methods, banking, insurance, commission, real estate, transportation, brokerage, wholesale, retail, importing and jobbing. There is usually a separate course for shorthand and type-writing, which includes grammar, spelling, dictation and practice in office routine; and another course, called the "English Course," for those students whose elementary knowledge is not sufficiently sound to warrant their entry into the higher departments. This course comprises:—Arithmetic, penmanship, English grammar, reading, spelling, United States history, geography, and letter-writing.

I may best indicate the scope of the work of these institutions by quoting shortly from the prospectus of one of the soundest of these American colleges, as follows:—"This college is devoted to the special training of young people who intend to devote themselves to mercantile or allied pursuits. Its course of study is arranged with the aim to develop the business capacity of the pupil, and to impart a knowledge that will lay the foundation for a successful business career. The essential feature of the system is individual teaching."

The great feature of these colleges is, however, the actual business practice. After having completed a certain amount of theoretical work, the student is advanced to the counting-house department, which is not a mere figure of speech, but an admirable and altogether realistic representation of a business house. Indeed, in the larger institutions one would find an entire floor of the college building fitted up, with here a counting-house, there a bank, with its different divisions, and in other parts of the hall, offices representing firms of various descriptions. The student then actually performs in turn the duties of salesman, shipping clerk, cashier, receiving clerk, bill clerk, stenographer, book-keeper, &c. In some places he actually carries on business with other cities by correspondence with students in similar colleges in, say, New York, Boston, Philadelphia, and Chicago. He orders or ships goods, draws drafts, makes and receives remittances, and, in fact, performs all the duties of a man of business. At the time of my visiting a college in Philadelphia, there was actually a "public auction" going on, the instructor being mounted on a rostrum and the students in various parts of the room bidding against each other as to the manner born, paying with dummy cheques, keeping practical accounts of the business and showing results. In another establishment in the same city I noted that from the first day of entry a student was set-up in business, a cash capital was given and deposit-slip made out. He went to the bank (an actuality) from time to time, presented his money and deposit-slip and went through the regular banking routine. At a subsequent period he occupied a position in the bank, either as receiving cashier or paying clerk.

In the Gem City Business College in the town of Quincy (Illinois), I saw a most elaborate and perfect system of practical business training. An immense hall was fitted up with four banks, each bearing its title plainly over the front representing the four sections of the country. There were, in addition, two wholesale houses, two commission houses, one railroad express and freight company, one insurance and lsnd office, and so on. Every description of document used in a house of business is brought into use in this department. There were also clearing-houses, and, finally, an actual bank in the office of the college, where the actual deposits of stupents were received, and also occasionally of non-members of the school. In most of the colleges there was exhibited the market report for the day, just as it was received from the Board of Trade Department of the State.

There can be no doubt that this elaborate and exhaustive system is attended by very good results, and that the young people of both sexes who have gone through such a course intelligently, are fairly well qualified to take a place in any house of business, without requiring that coaching and supervision which the raw youth fresh from the public school invariably needs, and which it is generally nobody's business to supply. But, at the same time, it is highly probable that the completed student—or "graduate," as he is termed in America—has in reality no sound knowledge of any particular commercial subject, but rather a general and often hazy idea of office routine, and in this respect, it seems to me, the American method falls far short of the English. If I might be permitted to crystallise into one sentence my criticism of American business training methods, I should say there was much to gratify the eye and to make an attractive display, but the great outlay involved in all this ornamentation and lavish expenditure on mahogany, plate-glass, and gilding prevented the employment of a staff of teachers adequate to the purpose, and able to carry out what is so desirable, but what in America is found to be but a mere figure of speech, namely, strictly individual instruction.

The chief difference between American and English methods lies in the importance they attach to what is called "business practice," as against our system of specialised teaching in individual commercial subjects, such as shorthand, book-keeping, type-writing, French, German, and Spanish. My experience showed me that while there was something to learn, from an English point of view, in the American methods of training in office routine, the teaching of shorthand and other individual subjects was much inferior to that obtaining in England.

In the short time at my disposal it is impossible for me to give as exhaustive and clear an account of American methods as I should wish, but I trust I have indicated with sufficient plainness the lines on which American business training is conducted, and I must now pass on to consider for a few moments the methods of commercial education in England.

I will take as my type an institution which may well be said to represent commercial schools in Great Britain, inasmuch as it is not only the largest of the kind at the present time in any English-speaking country, but furthermore stands as the parent, the fountain and origin of them all.

Students entering these schools have as a rule the right to select the subjects, either singly or in groups, which they are to be taught. Thus, for instance, one may take shorthand, another shorthand and type-writing, a third these subjects plus book-keeping, a fourth may add one or two modern languages to this course of study, while a fifth may take one or two odd subjects, such for instance as arithmetic, penmanship, and Spanish, and so on. The range covered by these institutions is a very wide one, and comprises generally, shorthand, type-writing, book-keeping, office routine, arithmetic, penmanship, grammar and composition, French, German, Spanish, Italian, English to foreigners, and civil service preparation. From such a comprehensive bill of fare it cannot be a difficult matter for parents, guardians, or responsible students to choose items suitable to their requirements or their tastes. Each subject is taught in a separate department, and has its own special staff of tutors; indeed, where the patronage given to a subject is exceptionally large, it may be split up in into many divisions, as is usually found to be the case in shorthand teaching. In the modern language sections "native" masters only are engaged in each.

One of the great advantages offered by these schools is the facility given to men of business and others to take instruction at almost any reasonable hour of the day or evening. For instance, teaching is going on from 10 a.m. to 9 p.m. daily, with short intervals at one and four, and as there are no long vacations, the only blank days being those generally regarded as public holidays, such as the Bank and other national holidays, it is conceivable that a student may take his lessons at any time suitable to himself. This is rendered the more easy by reason of the system of individual tuition, which obtains throughout. Each student is attended personally in each department, and is thus able to come and go entirely at pleasure, and without disturbing the studies of others present, or the continuity of his own. This admirable arrangement is no doubt accountable for the fact that so many business men take advantage of the facilities offered in the subjects, for instance, of shorthand, book-keeping, and modern languages.

It is scarcely possible, in the time at my disposal, to give anything like a clear idea of the fees charged at the English commercial schools. There is usually a separate fee for each subject based on the length of time taken by a student of average capacity to complete the subject. For the fee of £20 (equal to the charge made by the American colleges for a year's instruction) the student can take up shorthand, book-keeping, business training, penmanship, arithmetic, and typing, and be guaranteed completion in them, without any time-limit whatever.

Perhaps the chief point of distinction between the American and English methods is the relative difference in the importance attached to the study of shorthand. In the States, shorthand is taught in a very perfunctory way, and as a proof of this, I may mention that while the principals of colleges there regard women as very much the inferior of men as teachers, the teaching of shorthand is, nevertheless, generally placed in feminine hands. In this country, on the other hand, shorthand is considered, and very rightly to my mind, as of paramount importance. It is one of the surest passports to employment which a young man or a young woman can possess, and while it is a great fallacy to depend on shorthand alone as a money-earning qualification, it does undoubtedly obtain recognition at the hands of thinking employers, and frequently gives one candidate a personal interview with the employer, while an otherwise equally efficient applicant is passed over on account of his want of acquaintance with this subject.

I spoke just now of the young woman seeking employment, and I am reminded of the immense part that shorthand, in conjunction with type-writing, has played in the opening-up of a field of remunerative occupation for young women. It is a few years ago, comparatively, that the type-writer made its appearance in this country. The suitability of type-writing to women as an occupation was very readily recognised, and the influence which the advent of the type-writer has had, together with the twin art of shorthand, on the business life of this great city cannot be lightly estimated. So far, women have proved themselves somewhat superior to men in the use of this ingenious machine, and in regard to shorthand it may be said that although they were slow to catch up to their brothers in the manual dexterity, they are now surely and unmistakeably proving their right to be placed on an equality with their male competitors even in the matter of speed. Whether the sexes are equally suited to the work of a house of business is another question, and one which I do not propose to go into to-day. I may perhaps be allowed to say that although at first employers looked somewhat askance at the prospect of young women in the office, the number of houses of business employing ladies as clerks, book-keepers, and so on, at the present time, is increasing enormously day by day. Ladies have shown an adaptability to office routine and an aptitude for commercial methods which have surprised their most hostile critics, and excepting only the few young girls who enter upon this work with no more serious idea than to earn a little pocket-money, there is no valid reason why women should not be considered the equal of men as clerks, book-keepers, or secretaries.

Great stress has been laid on the importance of a sound commercial knowledge of the French, German, and Spanish languages, all or any of them. I remember hearing the present Attorney-General enforcing this point most eloquently and convincingly, and there can be no doubt that the addition of one or more of these languages to the business equipment of a youth is an immense help, not only in the obtaining of suitable employment, but in enabling him or her to rise to higher and better positions. The Attorney-General, in the speech referred to, said:—"In order to carry on the commercial business of the world it is absolutely necessary that the knowledge of foreign languages should extend, and particularly necessary in a country of such predominating commercial importance as England." I think we can all heartily coincide in that opinion. We know how much and how often the young German is paraded before us as an admirable linguist. It is true enough that those who come over to this country pick up a working knowledge of our language with a facility which is little short of marvellous, but in this connection we must not lose sight of the assistance rendered to the youths of continental countries by the money which is spent by the various Governments in subsidising their technical schools and commercial colleges. In Great Britain it is left entirely to private enterprise, and, as I have pointed out, often in the teeth of opposition from quarters where we should have most right to look for encouragement. But much is being quietly done in England at the present day to fit the youth of this country to take his place in the battle of life on equal terms with his continental rival.

In the institution to which I am particularly referring the main object kept in sight is "practical training for commercial life," but, nevertheless, the advantages of a literary and conversational knowledge of French, German, &c., are by no means lost sight of. Each of the languages has a special department devoted to it for practice in conversation, and the student is thus enabled to get a stronger and more thorough grasp of the language than would be possible from book work alone.

One of the difficulties which has to be faced by the managers of these colleges, is the question of the separation of the sexes in the classrooms. In America no attempt at this is made, the general opinion being that as girls are being taught to qualify themselves for business houses, where they will be unavoidably thrown into contact with the opposite sex, it is just as well to let them associate in the business college. I am quite prepared to hear expressions of dissent from this opinion, and I may add that in this country some attempt, at any rate, is made at the separation of the sexes, especially where the numbers are very great and will warrant a separate staff for each. Because, of course, these are all proprietory establishments, not run on philanthropic lines, not subsidised by Government, or otherwise, and the working of the business on profitable lines has to be made a consideration. No doubt as time goes on, and more and more young women embark upon a business career, the need for any consideration of this aspect of the question will grow smaller still.

The question of the fitness of an intending student for a certain course of study is a most important one, and in the course of my American investigations, I directed special attention to the question of entrance examinations, of which I had heard a good deal before my visit. Several of the proprietors of the colleges spoke very loftily of the rigid entrance examination which they imposed upon all prospective pupils. Some gravely assured me that they rejected on an average fifty to seventy-five per cent. of the applicants on the ground of general unfitness. I was at first inclined to accept these statements as so much gospel truth, until I arrived at Brooklyn, where I had an interview with the principal of a very well-known and important business college. This gentleman was spoken of with remarkable unanimity in the highest terms of praise by the principals of colleges in almost every city I visited. While they frequently abused one another heartily, they agreed in regarding this gentleman as able, conscientious, of good business abilities, and one whose opinion would always be entitled to great respect. When I put the question of the entrance examinations to this gentleman, he replied with almost the suspicion of a wink, "You may take that as pure Yankee bluff. Business colleges here are run for a profit, and their proprietors would no more reject an applicant, no matter what his mental attainments might be, than they would turn their backs on a fat political job." So much for American opinion on this subject. Frankly, I may say, that the practice in this country is to take all comers, and to advise those who are deficient in subjects they have not arranged to take up to remedy the defects without delay. It must not be forgotten that English commercial colleges have great influence in placing their efficient students in business, and in this way it is possible to bring pressure to bear on those who are lacking in business handwriting, for instance, to make good the deficiency. But in my experience, which extends now over some sixteen years, I have found that the student who presents himself or herself at these colleges is usually one whose early training has not been neglected, one who is very well qualified, generally speaking, for the career he or she is endeavouring to follow. Besides, the teaching of a subject like shorthand, for instance, necessarily involves abundant instruction in grammar, spelling, composition, punctuation, &c., and inevitably imparts an all-round knowledge of men and things which in itself is a liberal education. It widens the horizon of these young people in a very marked degree. Speaking of employment, I might add that the demand for capable stenographers, typists, book-keepers, foreign correspondents, &c., is very healthy, and the general experience, for some years past in these colleges, has been that the difficulty is found rather in coping with the demand than in an over supply of applicants.

I cannot omit from such a paper as this my tribute of gratitude to such bodies as the Society of Arts, the London Chamber of Commerce, and kindred organisations, for the splendid impetus which they give to the thorough study of commercial subjects by the examinations they conduct from year to year. They have been the means, to my certain knowledge, of arousing enthusiasm in the breasts of thousands of young students, enabling them to reach a high degree of perfection in the subjects I have referred to, when without this excellent stimulus they might have been content with a respectable mediocrity.

The demand for commercial education is at the present day greater than it ever was. The institution I have been taking as my type receives annually something like 3,500 to 4,000 new students, and with such a patronage, drawn, as I have already said, most largely from the best of the middle-class families in the country, the position it occupies in the educational world is a most important, as well as a most responsible one. That it performs its work efficiently is best evidenced, I think, by the fact that more than half of its new business yearly is the direct result of the recommendation of former students. To those interested in the future welfare of English young men and young women, it is indeed a gratifying thing to witness the energy which they throw into their studies, many of them attending in the evening after a long day's hard work, with the object of improving themselves, and still further fitting themselves for the work they have undertaken.

I will conclude with the hope that the paper I have had the honour of putting before you will cause you to agree with me in thinking that commercial education in this country is a real live force, tending to the general good, and entitled to the respect, if not to the support, of all who have at heart the preservation of our greatness as a commercial nation.

Sir OWEN TUDOR BURNE said he should like to compliment M. Jacques Siegfried upon his paper, and he was sure others would agree with him that it was one of the most valuable contributions to the Congress. He was surprised to find that the higher secondary technical education in France was so infinitely superior to that in England. With regard to the paper read by Mr. de Bear, he wished to bear his testimony to the excellence of the Metropolitan school which was mentioned in the paper. He had the honour of inspecting that school two years ago, preparatory to giving away the annual prizes, and he thought it one of the best institutions in England, and well worthy of a visit from anyone interested in higher secondary commercial education.

THURSDAY AFTERNOON, JUNE 17.

SECTION B.

Sir OWEN ROBERTS, D.C.L., F.S.A., in the chair.

SYSTEMATIC COMMERCIAL EDUCATION.

BY T. A. ORGAN, B.A.

Catch-words and catch-phrases play a great part in English life, and in recent years the phrase, "the ladder from the gutter to the university" has had a very great influence in educational polity. It expresses what has been the dominating idea in the minds of expert educationalists, and it has been the phrase most often used by the politician who desires to obtain cheap applause for the zeal of his party in promoting popular education. In many cases it has led to the useless frittering away of large sums of public money. I refer to the part of the money expended in scholarships, the holding of which has neither benefited the scholar, nor led to any useful work for the community.

In the majority of cases it is a cruel kindness to tempt a poor lad by means of a scholarship to seek to attain a university degree. While so doing he is actually disqualifying himself for work which otherwise he might do well, and as an adult he finds himself the possessor of qualifications which are useless, either because there is no demand for the services which he is capable of rendering, or if there is a demand, because it is supplied by men who have more influential friends.

Theorists will tell me that these views are utilitarian and non-educational. This is neither the time nor the place to deal with this assertion, beyond saying that I do not admit that a liberal education cannot be given on utilitarian lines.

There is an idea underlying the "gutter to the university" phrase which its originators had well in mind, but it has become lost in the too literal interpretation of the words. Commonly the "gutter" is now understood to be the elementary school, and the "university" one of the corporations with degree-granting powers. If the aim of those who so glibly use the words is to afford opportunities innumerable to the lads of the public elementary schools to enter as students at the universities, then in the interests of these lads, I enter a respectful protest. If, however, the words are taken to mean the provision for all of equal educational opportunies to obtain a "preparation for complete living," one can accept the phrase as fully describing the true educational ideal. As now commonly interpreted, it is harmful to the individual, and prejudicial to our national interests.

"A Preparation for Complete Living."

At a comparatively recent date, both theoretically and practically the man of education was prepared to live by learning sufficient Latin and Greek to enable him to state at a later date that he had forgotten it, and even now it is only *theoretically* that the halo of sanctity which surrounded the ancient classics has disappeared.

I am aware that in many of our secondary schools there is a "modern side," but, to use the words of the Schools Enquiry Commission :—

> "The modern side of a classical school usually degenerates into a refuge for boys without ambition."

What was true at the date when this Commission reported is largely true now, although there are many notable exceptions. How can it be otherwise, when nearly all the scholarships and prizes of the secondary schools are given to those lads who pass brilliant examinations in subjects which fit them for competing at a later date for university scholarships, the gaining of which will bring fame and new pupils to the school. The masters are usually men who have distinguished themselves at their respective universities, and naturally they are inclined to encourage their best lads to work along similar lines. The preparation of two or three brilliant lads annually for the university is much more congenial work than drilling the average boy in subjects which will be of use in practical life. That changes are being effected in the curricula of old established schools is true; but these changes are more apparent than real, and will be so long as the only appreciable test of the efficiency of the ordinary secondary schools is the university local examinations. One looks in vain for a school prospectus which states that an old boy has distinguished himself and brought honours to his school by becoming the manager of a drapery establishment, the chief clerk of a bank, or the chief engineer on board a liner. On the other hand, reams of paper are devoted to advertising the university scholarships won by lads who have been forced in the educational hot-house into brilliant, yet feeble plants, which will die fruitless when placed out in the world.

The True Function of Secondary Education.

As an abstract proposition it will not be denied that the true function of secondary education (as well as all other education) is "preparation for living," nor that this "preparation" must vary with the mode of "living" for which the pupil is intended. It is only recently that systematic efforts have been made to vary the preparation, but sporadic efforts have been in existence for a long period. These have usually ended in the disappointment of the originators and in disaster to the pupils.

No thoughtful person decries the literary side of education, but when that side is exclusive and leaves no room for scientific and technical training it is not effective for the good of the commonweal. This was well stated by the Secondary Education Commission, who, in referring to the three branches of secondary education—literary, scientific, and technical—said :—

> "All have, in our view, a claim to be considered in the course of studies of every secondary school, and the last of the three will thrive all the better if the two former receive their fitting meed of recognition. Technical education must be considered, not as the rival of a literary education but as a specialisation of it."

Before that Commission sat, the technical industrial side of education had been vastly strengthened and improved, but I submit that improvement in the technical commercial side had not kept pace with modern requirements and ideas.

"One-sidedness" was the charge which was formerly made against our system of secondary education. It was said to be too literary.

"Two-sidedness" is the burden of my complaint in that the literary and industrial sides are excluding the commercial. I know the school difficulty which arises out of the already over-burdened curriculum, but I maintain that the school training of the child above 14 years of age should be along lines which will prepare him for the life which he is intended to live, and not along a line or a number of lines which in his particular case lead nowhere.

Systematic Commercial Education — A Necessity.

I submit that to-day the educational necessity is a systematic course of commercial instruction. I use the term "systematic" as its omission would be met by the assertion that the opportunities for commercial instruction exist in the form of evening classes, &c. These I regard as worse than mere stop-gaps, for they have lulled us into security, as on these worthy, but ineffectual attempts to supply a want, we have relied to the national loss.

It is not necessary to recall to your minds the skeleton which appeared at the commercial feast of last year in the shape of a book entitled

"Made in Germany." The statistics given in that book, and the deductions therefrom, have been the subject of much controversy, but its author and all his critics agree that the lengthy commercial strides which Germany has made are undoubtedly due to her superior commercial education. A pessimistic attitude and a belief that we are beaten in the race for commercial supremacy are absurd. On the other hand, it is unwise to adopt the ostrich procedure, and to blind ourselves to the fact that other nations are pressing hard upon our heels in the commercial race.

The recent official report made to the Duke of Devonshire contains these remarkable words :—

> "And while it is possible that the aggregate value of the foreign commerce of Germany in comparison to that of Great Britain has been over-estimated, there can be no doubt that in certain industries our supremacy is seriously challenged. Germany is making enormous strides."

This is the testimony of Mr. Monaghan, the American Consul :—

> "That if his country and ours did not meet Germany more thoroughly and more practically in the school, each would in the course of a few years be compelled to yield to Germany the first place in all the higher and more profitable fields for manufacture and commerce."

Going from Germany, we find in the journal of the Board of Trade, issued last month, a foreign report which contains the following :—

> "Entire countries, especially in the new world, which at one time might have been considered the 'preserves' of the English merchant, are now overrun by the agents and travellers of the United States."

A perusal of the reports of our own Consuls has convinced me that there is cause for grave alarm. The foreign workman cannot produce a better and cheaper article than his English fellow, but the means taken by English houses to place that article on the market are of a character greatly inferior to the means employed by foreign houses.

Let me quote a concrete instance as given by our Egyptian consul. The incident occurred within the last few months. A foreign Government asked for tenders for four portable engines, 12 horse-power *effective*, with a guaranteed coal consumption per horse-power. Many English tenders were received for engines, 12 horse-power *nominal*, equivalent to 30 horse-power *effective*; the price of course being higher than that of those who tendered an *effective* horse-power. This mistake lost Austrian firms, these being in Turkish language and currency. The natural result followed. The tender of the English firm was not even examined, but an investigation after the contract was made showed that the English price was the lowest, and that the work had gone to an Austrian house because the English terms were quoted in our comparatively unknown and complicated currency, and in our own language.

In both these cases, a loss accrued to English trade, a loss arising solely out of want of skill in "getting the article on the market."

WHERE WE FAIL.

It is agreed on all hands that in the matter of technical industrial education we are making up leeway, and on the other hand there is quite as decided a concensus of opinion that in technical commercial education we are drifting to leeward as helplessly as ever. Let me give a few of the many facts upon which I base this statement.

The commercial travellers who visited Palestine in 1896 were distributed among the nations as follows :—English, 4; Germans, 29; Austrians, 18; French, 13; Swiss, 3; Italians, 2; Belgian, 1. These are exact figures as given by our own representative, and other foreign reports tell the same tale but the figures are not given. It is agreed that although advertisement tends to promote trade, it can never have the same effect as travelling agents thoroughly acquainted with the views and wishes of their principals and possessing a knowledge of the language, customs and currency of the land in which trade is sought.

As to advertising, we are far behind our rivals. Our Spanish representative says that the English catalogues are useless and absurd, showing not only crass ignorance of the language but also of the technical details of various trades, and that the larger number of them quote prices in the English currency. Contrast this with the "push" of the German. He takes care to catalogue and describe his goods in English when advertising in our own or any English speaking country. It is only within the last few weeks that Mr. F. H. Burford, our Victorian representative, reported that our bicycle trade in that colony was suffering severely owing to the inferior style of the catalogues which are being circulated. A number of these catalogues were submitted to good judges, and their unanimous award was :—United States, best; Germany, second; British, worst.

In the foreign reports, complaint is rife as to the English firms the contract, and the work placed in an Austrian house.

And another, which is within my personal knowledge. An English firm tendered for a large quantity of machinery required for a Turkish manufacturer. The terms of the tender were in the English language and currency. Other tenders were received from German and the ignorance of the English merchant respecting foreign dues and customs. A glaring instance occurred only recently. On a certain textile fabric the import duty is 5s. 4d. per kilo. if delivered untaped—if taped, three times as much. Our Consul in that country reports that ignorance or negligence of this fact has done much to lose for England the trade in that article. The foreign houses are most careful to make themselves thoroughly acquainted with the various dues and customs, and in many cases they quote prices which cover these and represent the cost of the article delivered at the customer's own door. One can well understand the great inducement offered to the retailer by the firm which quotes "duty free" as compared with the one whose quotation is only part of the price, the other part not being ascertained without a large amount of trouble.

With more of these instances one cannot deal in detail, but it may be taken as a common-place in trade reports—not only by Englishmen but by foreigners—that the British traders and his representatives are wanting in resource and that they are not well equipped with the arms of their profession. For foreign trade especially, the English manufacturer has to rely largely on the foreign traveller, who learns his employers' trade secrets and his trade weaknesses and uses them as he pleases.

One of the Causes of this Failure.

In all but the elementary branches of English education we have worked along old lines and travelled in the old ruts. The bells of our university leaders jingle, and with pack-horse constancy we have blindly followed, not caring whither. The results are disastrous, and I cannot do better than call, as witnesses to uphold my statement, the London Chamber of Commerce, who say:—

> "Business men have been galled by the constant proofs exhibited to them of youths seeking employment ill-equipped for their calling, ignorant of the elements of commercial life, and lacking the essentials of utility, so long as they as employers confined their attention to the engagement of youths trained in British schools. These same employers have been equally concerned at learning that it was not possible to find in the labour market a British youth—or, if possible, then but rarely, and as an exception proving the rule—capable of competing with Continental youths who have had the advantage of 'practical' education, whose tuition has been guided by the career they had in prospect, and who to the commercial man of to-day are valuable. The employment of foreigners has hitherto been compulsory in English business houses."

That there is a lack in English schools of proper training for commercial life, and that as yet no successful systematic effort has been made to supply the gap in our system, is evidenced by the statistics given by the Chamber of Commerce of the examinations which they have conducted. Although 200 London firms have undertaken to give preference, in selecting assistants, to lads who possess the Chamber of Commerce certificate, yet after the scheme has been in existence for over six years, last year only 49 candidates presented themselves for examination, 40 sitting at London, 6 at Aberdeen, and 3 at Portsmouth. In 1890, 65 London candidates were examined; in 1891, 86 candidates; in 1892, 79 candidates; in 1893, 76 candidates. When it is remembered that in London alone there are 105,000 business men and women who style themselves clerks, the signal failure of the Chamber to induce schools to train on commercial lines is apparent, especially when we see that in 1896 the candidates were half the number of those in 1891.

That the supply of English commercial assistants is less than the demand is patent, for the report of the Chamber states:—

> "The most eloquent fact that the Chamber can adduce as an encouragement to proceed with its work is that no holder of the junior certificate has yet endeavoured unsuccessfully to obtain a situation through the Chamber formerly, or latterly through its employment department."

"Commercial education" figures largely in the prospectus of many schools, but only a very few send up their lads for the Chamber of Commerce examinations, in spite of the manifest advantages accruing to a successful examinee.

Foreign Progress v. English Conservatism.

Alertly progressive in commercial education are our foreign competitors, while we are blindly traditional. Our greatest competitor is Germany, and at the present moment she has 200 schools and institutions devoted solely to commercial training; these have 24,000 pupils, 19,000 being elementary and 5,000 being intermediate. France has 9,000 pupils in her commercial schools, and Italy has 8,500.

Russian Progress.—The latest information from Russia is of an instructive character. Her first commercial school was established in Moscow in 1772, and its definite aim is shown by the words of the statute under which it works:—

> "To give to its pupils a general education, and to prepare them for commerce, and for taking the post of book-keepers, controllers, and chief clerks to manufacturers."

In 1885, Russia had 36 of such schools, but in 1894 it was found that the number had been reduced to 25. The Russian government, with a foresight which is lacking here, immediately placed the matter in the hands of its most powerful government department, the Ministry of Finance. This department is setting up new schools in which the pupils are to receive the necessary training, for service in the capacity of clerks and small traders, and in industrial banking and insurance methods. "One-class" schools are being established for those pupils whose lack of means prevent them from remaining for a long course; and "three-class" schools for the children of more well-to-do people; and finally, employers' classes for those who can attend in the day as well as in the evening for a long course. The programme of each school is adapted by the Ministry to the local needs.

Austrian Progress.—Mr. J. Goldschmidt, the United States Consul-General in Vienna, gives details with reference to the work carried on in that city. A full description is given in the *Board of Trade Journal* for August, 1892. He says:

> "In these special commercial schools, pupils are actively brought into contact with practical life; they regularly visit the public collections of commercial and industrial art, industrial establishments and make 'instruction journeys' to the great centres of commerce under the guidance of the professors. Despite a high fee—150 florins annually—the number of pupils has steadily increased, as it was found that those who had passed the academy could command their price in the market."

The instruction does not end in and around Vienna, for many of the students have been, and are now, in England, in order that

> "as opportunity offers, they may return to their native state and put their newly acquired knowledge to use in the marts of the world."

At the risk of being tedious, I quote two other extracts from this valuable monograph:—

> "1. England is thus (by training these young Austrians) raising up for herself in the near future a new, most intelligent, capable and determined competitor."
>
> "For some years past the director of this special school has been applied to by foreign governments to give complete practical explanation of its organisation and system, while banking and commercial houses in London and elsewhere, requiring specially trained and capable young men, have been applied to and supplied by him from the students under his charge."

German Progress.—A correspondent of the *Monde Economique* says:—

> "The Germans have shown themselves during the last few years to be on the way to become past masters in commercial matters. Their energy, patience, activity, and spirit of enterprise are remarkable, and at the pace they are going they will soon succeed in obtaining the commercial supremacy on the chief markets of the world."

The correspondent then deals with the means employed by the Germans with a view to developing and encouraging the native qualities of their race. He attributes much of their successes to their commercial education, and he especially calls attention to a society founded in Hamburg in 1858, with the object of procuring situations for young men desirous of entering trade, in which they may have facilities for learning the usages of international commerce. At the time of writing, the correspondent states that the society, consisted of 34,000 members, and that it had 170 branches. Such a society formed in England would be a valuable adjunct to any system of commercial education which may be hereafter established. To pile up instances would avail little, but it would be easy to produce evidence of a most conclusive character, showing that the countries which are increasing their trade are also those which are giving the most attention to systematic commercial education.

"COMPETITION BECOMING MORE ACUTE."

> "Indeed, there are indications that in the immediate future our own countrymen will have to encounter a competition far more acute than anything they have had yet to grapple with."

So say Sir Philip Magnus and his colleagues in their report of last year, a report based on personal observation of the methods of trade adopted in the countries which they visited. This competition we are preparing to meet on the technical industrial side of our education, but on the technical commercial side we have done nothing worthy of a name.

There are encouraging signs, for the Technical Education Board for London is alive to the necessity for immediate action. In their last report to the County Council, referring to education, they say:—

> "One of the subjects constantly kept in view by the Board has been the importance of commercial education; there is no direction in which better technical instruction is likely to be more effective in promoting the industry and well-being of London."

A few weeks since the Board appointed a special committee to bring up plans for effective work in this direction, and if London lead well in this matter the provinces will assuredly follow. At present in the higher branches of commercial life the foreigner holds the field, but there is no reason why he should continue to do so, provided we supply systematic training for our native talent.

In his "Expansion of England" when referring to our war with France in the two first decades of the eighteenth century, Seeley says:

> "England and France stood in direct competition for a prize of incalculable value. The prize was the control of the markets of the world."

The ethics of a war, based on such a motive, I am not prepared to defend, but the value of the prize for which both nations spent so much blood and treasure is beyond question. The commercial war is no less keen now, although the fighting men are clothed in fustian and broadcloth and the field of battle is the manufactory and the counting house.

Energy, brains and physique we have, but in commercial education our methods are antiquated, our guides are not sympathetic, and we must decline to follow the latter and modernize the former if England is to remain in the forefront of the commercial world.

THE TEACHING OF ECONOMICS.

By W. A. S. Hewins, M.A.,

Pembroke College, Oxford; Director of the London School of Economics; and Tooke Professor of Economic Science and Statistics at King's College, London.

In a paper which I had the honour to read before the Society of Arts last December, I pointed out that the provision of economic teaching in England was incomplete and unsatisfactory, and I expressed the hope that economic study would be promoted by the organisation of higher commercial education. I assumed that a scientific training in economics was an indispensable element in any well considered scheme of commercial education. Economists are, I think, rather more ready to recognise the advantage to their science of direct contact with the business world than the business man to admit the obligations industry and commerce owe to the economists, and, although even a slight acquaintance with the history of the 19th century would suffice to show how many important national movements have been inspired by the teaching of economic writers, it is not obvious that the working efficiency of the average clerk is increased by an elementary acquaintance with the principles of economics. I will, therefore, endeavour to state, as precisely as I can, the grounds for what some people will think the extravagant claim I have made on behalf of economic training.

One or two examples will, perhaps, make the matter clearer. None, I presume, would hesitate to admit the necessity of scientific training in the insurance world. Here we have a vast and complicated system, involving great sums of money and the happiness of many thousands, resting upon a basis of what is, after all, abstract reasoning. It is seen that the phenomena of life and death, of accident and disease, obey certain general laws which can be stated with mathematical precision, when we have to deal with large numbers of human beings, and we praise or blame different societies by applying to them purely scientific tests. No educated man would dream of dissociating the scientific study of vital statistics from the business of insurance. It so happens that, for various reasons, the actuarial department of human affairs has been reduced to "law and order" to a much greater extent than some other departments. But the existence of scientific principles, not indeed of universal validity, but relative to the existing structure and organisation of society, is equally certain in connection with other subjects. It is difficult to see how the most practical problems of currency, banking, international trade, or factory legislation, could be intelligently stated without reference, explicit or assumed, to the underlying principles of economics. We have lately seen a Royal Commission referring to the teaching of the economists to elucidate some of the most practical problems of national finance, and a very high authority has informed me that, in his opinion, one of the main difficulties in unravelling the question of the incidence of local taxation is the incomplete treatment given to that subject by economic writers. The experience of the London School of Economics, where, during the last two years, we have had numerous courses of lectures on higher commercial subjects, shows that unless such courses are supplemented with a carefully arranged system of classes, at which the students can obtain systematic training in economics, it is impossible to make much progress.

So long as we think of commercial education as some general course of study appropriate to any and every business man or clerk, it may be possible to discount the value of economic training. But directly we face the real problem, viz., the provision of suitable courses of study for groups of men and women engaged in certain well defined employments, very brief experience will show that the students must be well grounded in economics, and the question is reduced to the determination of the nature and extent of the teaching.

I believe the opinion is still very widespread that by economics we mean a neatly rounded set of general propositions which can be comprised in a small crown octavo text-book, and learnt like the multiplication table. So far as that is the case, it is easy to understand the objections to the subject felt by the great manufacturer on the one hand, and the artisan on the other. But, as Jevons pointed out, it is important to realise that economics is not one science but several. It includes, at any rate, in the English acceptation of the term, the pure theory, which can be carried to a very high degree of abstraction, the analysis of the actual structure of the modern world of business, the more or less inductive work of the historian and the statistician, the art of finance and administration, and many other branches. No economist, who devotes his whole life to the subject, can hope to become well acquainted with all its different branches, and it is at once obvious that in insisting upon economic training as an indispensable element in commercial education, it is necessary to carefully select the portions of the subject to be included in the curriculum. I suggest that the course should include (*i*) what we may call *Descriptive Economics*, which should be a scientific account of the more general features of the modern world of industry and commerce ; (*ii*) *Theoretical Economics*, which should include a careful and systematic training in the meaning and use of economic terms, and the leading principles of the science ; (*iii*) *Elementary Statistics*, a subject, I confess, exceedingly difficult to teach, but which should aim, not at turning out expert statisticians, but enabling the student to appreciate and use intelligently, for ordinary purposes of reference, the materials collected and tabulated in published returns. These three branches I regard as essential. Round these classes may be usefully grouped special courses of lectures on such subjects as currency and banking, commercial policy and the like. In their absence, either the special courses will not be followed by the best results attainable, or, to make them successful, each lecturer must waste time by giving the necessary explanations himself.

Dr. PYFFEROEN, speaking in French, said Mr. Hewins had strongly praised and advocated the teaching of political economy, which he considered an absolute necessity in a school which proposed to give a commercial education. He (Dr. Pyfferoen) completely agreed with him, but he would like to point out that political and industrial economy already formed part of the curriculum of all the Belgian commercial and technical schools, but were naturally of a kind adapted to those who wished to enter trades or professions, and of a more elementary character than the teaching of that science in the universities. Mr. Hewins had further seemed to be of the opinion that the teaching of foreign languages was without importance, from the point of view of commercial education. On that point, he thought it was as well to distinguish between the different degrees of education. Mr. Hewins had chiefly occupied himself with the question of superior education—naturally enough, inasmuch as he was the founder and director of the London School of Economics. But, in the lower and middle degree, the teaching of foreign languages, together with a knowledge of accounts, book-keeping, &c., were the principal subjects dealt with, and of the first importance. In Belgium the urgent necessity of developing commercial education was becoming more and more appreciated, and he thought no one would dispute that. Speaking of the lower middle class, it was necessary that they should be taught a knowledge of foreign languages, in view of the growing facilities of communication, and their increasing international relations.

M. JACQUEMART assured Mr. Hewins that in France political economy was not a neglected subject. The character of the teaching, and the extent of the study, of course, depended upon the status of the school, and was appropriate to it, but of all the schools of commerce he did not know one in which the teaching of political economy did not hold an important place. The science of political economy was the life of commerce—almost of the people—and so was taught to all those who entered their commercial schools, according to the importance of the school, and the degree of education which the pupils went there to receive.

Mr. G. N. HOOPER said that it was only on the previous day that the Council of the London Chamber of Commerce held a meeting, and had deputed him to say a few words to express the sympathy of the Chamber with their efforts. He would first like to thank the foreign visitors who had honoured them by attending the Congress for the kind reception given to the Royal Commissioners in their respective countries, and for the information which had been given about the systems of technical education pursued. He trusted their visit to London would be agreeable, and mutually profitable. The Chamber also rejoiced in the very great interest which was now being taken in the work they had been engaged in for the last twelve years. They had many difficulties to overcome, and progress had been slow, but it was now bearing fruit. They had received assistance not only from the head-masters of the great public schools of London and the provinces, but from the Universities of Oxford and Cambridge, from which they had expected to find a prejudice in favour of the older system of education, which, notwithstanding all that had been said, had produced a large number of very able men, who had greatly contributed to make England what she was. But on the part of the universities they found the greatest readiness to fall in with the views placed before them in reference to the education of those to be trained for commercial life. The Chamber also rejoiced in the higher position accorded to commercial men, compared with what it was many years ago, and they could not help thinking that the more highly and suitably commercial men were educated, the more capable would they be to conduct their own commercial affairs, but also the affairs of the country, to the advantage of both. In the course of the discussions, deliberations, and conferences that had taken place with regard to higher commercial education, the Chamber had sent a resolution, adopted by a unanimous vote, to the Education Department expressing the opinion that "in any new teaching university for London, the organisation should embrace all higher culture," and, as illustrations mentioned art in all its branches, agriculture, national defence, the organisation and equipment of armies and navies, naval architecture, questions of transport, such as the construction and equipment of railways, docks, harbours, and so on. They acknowledged with pleasure that they had received, from the School of Economics, in whose house they were at that moment assembled, considerable assistance in their endeavour to improve the higher education of commercial men. During the last two years courses of lectures had been delivered in their Council-room in order to identify the Chamber with the teaching of commercial history, commercial law, commercial geography, economics, besides lectures on special branches of commerce. They had also paid increased attention to the teaching of foreign languages, and urged that such teaching should not be confined to French and German, but should include Spanish, Portuguese, and Italian. There would be difficulties at first, but they might be overcome by the great public schools taking different languages, and so covering the ground. He thought they would see that the London Chamber of Commerce was taking its part in educational progress in no half-hearted manner.

M. JACQUES SIEGFRIED said that he desired to thank the London Chamber of Commerce, in the name of the foreign delegates, for the kind words which had just been spoken to them by one of its members. Their presence at that Congress was the best proof of their conviction that they thought international congresses a good thing. He desired to profit by the presence of a member of the London Chamber of Commerce by telling them that in his opinion the best way to promote technical education, and especially commercial education, in England, would be for the Chamber of Commerce to take the lead, because one thing which astonished them with England was the diversity of the different bodies who had charge of the general education system. Its diversity might have advantages in some respects, but undoubtedly too it had its disadvantages. There were three classes of commercial schools—the elementary, the secondary, and the higher, and if the London Chamber of Commerce would take the lead by establishing one school of each grade they would do a great service to their country.

Professor G. ARMITAGE SMITH desired to contribute a few words of experience, rather than to express any criticism upon what had been said. His claim to speak on the subject of commercial education was that he had been engaged in the teaching of political economy in one of the institutions of London—the Birkbeck Institution, in whose curriculum that subject held an important place—for the last 20 years, and also at the City of London College for a shorter period. One thing had struck him as being very remarkable, and that was the number of young German students who attended these classes; after working in an office all day they did not fail to avail themselves of the opportunity to study economics, and other subjects bearing upon the theory of business, and that fact gave him the impression that in Germany they paid greater attention to commercial education than we did here. He was pleased to think that commercial education and the economic study of commerce were beginning to receive greater encouragement. He had noticed in the discussion in the other Section that when gentlemen spoke of technical education they evidently limited their view to the consideration of arts and crafts—that is to say, to the production of wealth. In so doing they overlooked a very important fact: they might produce wealth, but find great difficulty in distributing it. There were many competent inventors and producers who were unable to secure the best market for a very excellent article. The distribution of wealth was as much a matter of science as its production. One need not be alarmed at the statements made in a recent book contrasting our trade with that of Germany. A very little knowledge of economics would show that many of the statistics contained in that book were very misleading. But some of its conclusions were distinctly correct, and one was that the Germans were studying the theory of commerce in all its aspects, while we rather held to the old-fashioned belief that trade would go where it had been accustomed to go. The world, however, was becoming one large competitive area, and we must play our part in it if we wished to maintain our pre-eminence. And, indeed, the progress of the whole world would be advanced thereby, for it was absurd to suppose that the scientific progress of one country was detrimental to others. He looked with great satisfaction upon an assembly of this kind, and he hoped that other County Councils would follow the lead of the London County Council in their efforts to promote commercial education.

Miscellaneous.

THE RUSSIAN COTTON INDUSTRY.

The cotton industry was established in Russia as early as the 18th century. Without any mills, yarn was distributed among the villages to the peasants, for the preparation on hand looms, of the simple national stuffs in common use. Soon small weavers' shops began to be founded, for twenty or thirty looms, and in the middle of the 18th century, the cotton goods industry began to spread so rapidly among the villages that it even killed the weaving of linen cloth. About the same time the calico printing industry came into existence, at first in the village of Ivanovo, in the Government of Vladimer, where by the end of last century there were already several such manufactories. At the same time it was held that Russian fustians and calicoes were immeasurably superior as regards dyeing to those of Western Europe. From the beginning of the present century the weaving of the coarser calicoes from English yarn began to spread in other places besides the Governments of Moscow and Vladimer, and the demand for yarn so increased that attempts were even made to build spinning mills. The war of 1812 retarded the development of the Russian cotton industry, but already in the seventies, it began again to rapidly develop, later attracting to itself a large number of workmen, and a considerable amount of capital. In the absence at that time of Russian machinery works, it was necessary to apply to England for spinning jennies; on the other hand until 1842, the exportation from England was prohibited and they could only be obtained by smuggling. Notwithstanding all these obstacles, in 1843 there were 40 mills, with more than 350,000 spindles, and ten years later there were nearly a million. The great growth of the Russian cotton goods industry is shown above all by the increase of the imports of foreign cotton into the country. In 1855 it still did not exceed 1,500,000 pouds (1 poud = 36 lbs. avoirdupois), while subsequently the average annual amounts were as follows:—1877-1881, 5,800,000 pouds; 1887-1891, 8,100,000; 1892, 9,400,000; 1893, 7,600,000; and 1894, 11,300,000 pouds. This is the cotton brought over the European frontier, but besides this there are 800,000 or 900,000 pouds brought across the Asiatic frontier. Nor is this all; a still more remarkable fact is the establishment of cotton plantations in Russia itself, developing year by year in Turkistan, the Caucasus, and the dependencies of Khiva and Bokhara. These plantations in the beginning of the nineties furnished over 3,000,000 pouds, and now probably the amount is considerably exceeded. Such being the progress made by the Russian cotton industry, the general demand of the Russian people for cotton goods is now satisfied almost entirely by the home production. The imports of yarns have diminished to such an extent that they form only 2½ per cent., while the imports of foreign textile fabrics do not exceed a three-hundredth part of the total Russian consumption. It is true that the exports from Russia of cotton goods is still small, they possess a certain importance only for Asia, which consumes every year an increasing quantity of Russian manufactures. In the number of spindles the Russian cotton industry has taken the first place on the continent of Europe. In 1891 there were 6,000,000 spindles in Russia; in France and Germany, 5,000,000 each; while in the other continental countries the numbers were below this. Thus to Russia's share fell one-quarter of all the spindles of the continent, and yet it was seven to eight times less than in England. The industry is protected from foreign competition by the imposition of heavy customs duties. The Russian cotton spinning industry in general does not go beyond the spinning of medium numbers, and is limited to No. 70. The annual average counts are 28 approximately. The English system is adopted for numbering cotton yarns, that is the counts are arrived at by the number of hanks of 840 yards each per English pound. These numbers are used for the manufacture of calico, which is finished by bleaching, dyeing, and printing.

THE PRODUCTION OF COCA IN PERU.

Before the discovery of cocaine and its anæsthetic properties, the consumption of coca was limited to the demands of those provinces in Peru in which the mining industry was carried on, the miners refusing to work unless they were supplied with coca. Twenty years ago, according to the *Economista* of Lima, the cultivation was only engaged in in districts which enjoyed the most favourable conditions of climate and labour. In the province of Otuzco, the systematic cultivation of coca was only carried on in the haciendas of Choquisongo and Sanjumas, and the production amply sufficed for the needs of local consumption and the mining industries of Salpo and Saypullo. For some time past the production of coca has greatly developed, and the province of Otuzco is at the present time the most important producing district in the north of Peru, its production exceeding even that of the provinces of Huamachuco and Cajabamba, not only as regards quantity but also quality. The number of plants is 2,700,000, and the majority of the plants in this province have not yet attained their full development. The coca from these districts is bought by two houses of Trujillo for the cocaine factories of Lima, and as they enjoy a sort of monopoly, the prices vary at will. The proprietors of the haciendas of Huayobamba and Cayanchal are proposing to establish cocaine factories in close proximity to their plantations, which may have the effect of lowering the prices. With the exception of the hacienda of Chuquillanqui, situated on the river of that name, all the other coca plantations are found along the river Chicama. To obtain the best results, coca should be cultivated in places where the temperature rarely falls below 24° Centigrade (75° Fahr.) and frequently rises as high as 30° (86° Fahr.) As regards the altitude of the plantations, those of Callancas and Huayobamba are for the most part situated at an elevation of 3,000 to 4,000 feet above the level of the sea; a few are found as high as 5,000 feet, but the product in these cases is of an inferior quality. The haciendas of Chuquillanqui, and a few others of minor importance, are situated at an altitude of about 2,000 feet. The quality of the coca varies according to the soil. That obtained from dry ground is better than the product of a moist soil. It is for this reason that the Chuquillanqui coca, although frequently attaining a height of about 9 feet, is far from possessing the strength and aroma of that produced in Callancas and Huayobamba. In the districts of Pampas and Callancas, there are about 80 small proprietors of coca plantations; at Compin the number exceeds 100, while at Chuquillanqui there are hardly 20, the cultivation of coca having only within the last few years been introduced in the latter district.

Notes on Books.

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A Glossary of Mining Terms. By C. C. Longridge. London: "The Mining Journal." 1897.

A glossary of this sort is of considerable value now that so many people are interested in mines and mining operations, especially to those who may be connected in various capacities with mining companies, without having any practical training or experience in mining operations. A great deal of trouble has evidently been expended in collecting from various sources terms used in mining in many parts of the world. Of course, many of the terms used are really of the nature of "slang," and have hardly yet taken their place in recognised language. But these are just the sort of words for which a glossary of this sort is useful, as they would not be found in the ordinary dictionary.

Although a cursory examination of the book gives the idea that it is very fairly complete, yet it is not difficult to suggest additions. The following certainly might very well have been included, and a more careful examination would have enabled the list of omissions to have been very considerably extended. "Jumper" is a well-known name for a boring tool. The process of "quartering" for sampling purposes is commonly used. "Stall" for the space between the pillars left to support the roof is in general use, so is the term "deck" for the divisions of the cage. Less familiar terms, but still terms quite as well known as many which are included in the book, are: "Lofting," support for the roof; "Jad," the groove in freestone quarrying; "Pecker," a word with a very similar meaning; "Keps," supports for the cage while the wagons are being run on and off; "Slope," the same as incline, a slanting shaft; "Hurry," a sort of shoot for delivering ore down a "rise;" "Swab-stick," used in drilling a hole for blasting; "Hoppet," the equivalent of "studdles" (timber props); "Van" and "vanning" are given, but not "vanner;" "Concentrate," a term constantly used for dressing ore is not to be found; the "dowsing" or "divining-rod" might well be mentioned; it does not appear under either head.

On the other hand, there are many words included which have no special connection with mining, such as geyser, fusible, fossil, evaporate, glacier, translucent, submetallic, and subtransparent. Many of the definitions are very good, but to define a "man engine" as a "machine by which men ascend and deeend a mine" is hardly sufficient. A brief description of the manner of its action ought certainly to have been given.

It may be noted that, at all events, in one place, under letter G, the words are not in their proper alphabetical order. This, of course, is a question for the printer, not the author.

It is, however, easier to point out faults than to indicate the merits of a compilation of this sort, which will certainly be found of considerable use for many purposes.

New York Elevated Railroad.—The compressed air motor cars, which were adopted on this railroad about ten months ago, have now run over 20,000 miles, and carried over 180,000 passengers.

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International Congress on Technical Education.

THURSDAY AFTERNOON, 17TH JUNE.

SECTION B.—*(continued).*

Sir OWEN ROBERTS, D.C.L., F.S.A., in the chair.

L'ENSEIGNEMENT DES LANGUES VIVANTES.

PAR L. SUTTLE, M.A.

Licencié ès lettres.

Personne ne peut nier que les enfants de quatre ou cinq ans peuvent parler facilement leur langue maternelle avec une bonne prononciation. Ce fait m'a donné à réfléchir et fort de 30 années de pratique continuelle du professorat, je me suis appliqué à faire une grammaire complète de la langue anglaise* basée sur le principe de faire parler mes élèves, non-seulement avec la même facilité que parlent les jeunes enfants leur langue maternelle mais aussi de lire livres, lettres, journaux, etc., et d'écrire correctement.

D'après la méthode de ce livre, la leçon se donne de la manière suivante: Dès l'ouverture de la classe, chaque élève remet au professeur la feuille sur laquelle se trouve le devoir donné, soit la version de la p. 14. Après avoir posé quelques questions sur les mots de la leçon précédente, le professeur lit distinctement la première phrase: le premier élève interrogé doit lire la même phrase en imitant la prononciation nette du professeur; puis il doit aidé par le professeur, en faire une question en anglais à l'élève, qui, aidé par le professeur, doit répondre en anglais. Le professeur, après avoir posé quelques questions sur les mots de la première leçon au second élève, lit distinctement la seconde phrase, que le second élève doit répéter; et, aidé par le professeur, il en fait à son tour une question au troisième élève qui doit répondre toujours en anglais. On continue de la même manière jusqu' à ce que chaque élève de la classe ait récité sa leçon, ait lu et parlé anglais, le professeur donnant la note à chaque élève en passant de l'un à l'autre. Finalement, le verbe est conjugué par tous les élèves: le premier élève dit la première personne sous les quatre formes "I have, I have not, have I, have I not;" le second élève dit immédiatement la seconde personne "thou hast, thou hast not, hast thou, hast thou not;" le troisième élève passe à la troisième personne, et ainsi de suite pour tous les temps. Le thème se fait de la même manière que la version. La classe se composât-elle d'une cinquantaine d'élèves, un professeur expérimenté et aidé par une bonne discipline peut, de la sorte, donner facilement sa leçon dans une heure. Quand les élèves auront fini la 22e leçon et qu'ils pourront conjuger couramment les verbes sur les quatre formes, affirmatif, négative, interrogative et interrogative négative, le professeur exercera les élèves dans l'emploi des temps primatifs, et les fera parler en s'adressant les uns aux autres de la manière suivante: le premier élève dira au deuxième: "Parle-t-il à son ami? Parla-t-il à son ami hier? et a-t-il parlé à son ami aujourd'hui." L'élève ainsi questionné répondra en anglais: "Oui, il parle à son ami, il parla à son ami hier, et il a parlé à son ami aujourd'hui." "Does he speak to his friend? Did he speak to his friend yesterday, and has he spoken to his friend to-day? Yes, he speaks to his friend, he spoke to his friend yesterday, and he has spoken to his friend to-day."

Avec des verbes différents, le deuxième élève parlera au troisième, le troisième au quatrième, etc. A chaque leçon, ou, si le temps fait défaut, toutes les deux leçons, la version qui vient d'être corrigée par le professeur doit être dictée par lui aux élèves qui à leur tour, redisent les phrases, et prennent insensiblement l'habitude d'orthographier correctement tout en formant leurs oreilles. Quand les élèves auront appris tous les verbes irréguliers le professeur fera repasser de la manière indiquée les verbes, pages 151 à 158, sous le titre, "Table des Verbes exigeant des Prépositions particulières," et autant que possible "Les Locutions qu'on ne peut soumettre à des règles," pages 357 à 378. A force de répéter dans la classe, de faire passer, pour ainsi dire, d'un élève à un autre ces locutions, la différence si profonde entre les formes de l'expression anglaise et française finit par devenir familière; l'esprit s'y habitue et la difficulté disparaît. Par exemple, si "j'aurais dû aller" veut dire, "I ought to have gone," "tu aurais dû aller, il aurait dû aller, nous aurions dû aller, vous auriez dû aller, ils auraient dû aller, veulent dire également," "thou oughtest to have gone, he ought to have gone, we ought to have gone, you ought to have gone, they ought to have gone" (page 93). Toutes ces locutions sont susceptibles de tournures semblables. La leçon se donnant de la manière indiquée, les élèves ne peuvent s'empêcher, même s'ils ont négligé d'étudier les mots et d'écrire l'exercice, d'apprendre à parler anglais. De même qu'un enfant de quatre ans qui a entendu journellement le colloque de ses parents ne peut s'empêcher de parler sa langue maternelle, de même un élève obligé constamment de faire des questions et de répondre à celles du maître ne pourra s'empêcher de parler anglais ; et si, de plus, il écrit et étudie avec soin tous les exercices de ce livre, non-seulement il parlera, mais il écrira correctement l'anglais.

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* "Grammaire Complète de la Langue Anglaise," par L. Suttle, M.A.

Dans une langue, il y a toujours des mots faciles à dire, à écrire et des mots techniques difficiles à dire, à écrire, que les élèves oublient le plus souvent, et qu'ils écorchent par conséquent. Ces thèmes et ces versions se composent (à l'opposé de toutes les autres grammaires) principalement de ces mots techniques, etc., très usités. L'élève peut, même sans professeur, apprendre les autres mots. Les racines grecques et latines d'où dérivent tant de mots anglais et français, placées en regard de ces mots, serviront aux élèves qui n'ont pas appris le latin et le grec.

Quand l'élève aura bien étudié ces 107 leçons et la prosodie, il n'a qu'à acheter les livres des meilleurs auteurs, et il peut les lire, les comprendre, et il peut faire des vers. Bien que ce livre soit une espèce d'analyse des phrases dont ce compose la langue anglaise, on doit se servir des versions pour la lecture anglaise. Après avoir fini la lecture des versions, où toute difficulté est expliquée, on peut lire n'importe quel auteur, et l'élève trouvera comme il a bien fait de finir tout d'abord la lecture de ces 107 versions et l'étude de tout ce qui se trouve dans ce livre, lequel lui servira de clef pour expliquer tous les auteurs.

Mr. HOWARD SWAN said it was hardly necessary in these days to suggest that such methods—a modification, he thought, upon some of the old methods—should be inculcated, when there was a widespread feeling now for the application of scientific methods, in which the true principles of psychology should have their place, to the teaching of modern languages. It was absolutely wrong to teach words that had no meaning behind them.

Mr. SUTTLE said that it was necessary for everybody to learn at some time of their lives "I have" or "I have not."

Mr. SWAN—Yes, but they should state what they have: and this statement should be a true one, and not false as usual in the lesson books. Language was a question of the expression of thought, and they should endeavour to arrange the thoughts of the students before teaching a language. Mr. Swan pointed out that it was often more imagination and not more technical knowledge that was required ; and gave an instance of carelessness and want of thought on the part of English manufacturers and merchants by stating that a large contract was lost to an English firm, tendering for some work in Turkey, by the fact that a German firm sent its tender in the Turkish language and gave its price in Turkish currency, whilst the English firm, which could easily have had the tender translated, tendered in English, and when the tender was afterwards translated and compared it was found that the English one was much more advantageous to the customer.

Dr. R. P. SCOTT said he felt well rewarded for coming to that Congress if only from having heard the excellent suggestion made by M. Siegfried as to the proper educational function of the London Chamber of Commerce in this country. He, along with Mr. Hooper, was a member of the educational committee of that body, and he could not help feeling, as he had said at its meeting, that the Chamber had not at all risen to its opportunities and the future which lay before it. It seemed to limit its idea of its duty to the holding of an examination. It held a junior examination which had not succeeded and could not succeed because it was not based upon the essentials of success. The Chamber of Commerce could take, as M. Siegfried had pointed out, a suzerain position with regard to commercial education. They could say "Such and such are the subjects, a knowledge of which the merchants of London desire in a young man of business?" They might indicate in what direction the present system is imperfect, they could point out the importance of modern languages, and merchants could say, if they would—and would say if they were well guided in this matter—that they would only have in their employ those who could speak colloquially one or two languages other than English. The point has been raised of the founding of the right kind of commercial school, and, as had been pointed out, there were three grades of schools that might be founded—a primary school, a secondary school, and, if he might so call it, a college school—all dealing with different parts of commercial education. But it was for the Chamber of Commerce to say what was needed in those schools, and either to found them themselves or get the educational authorities of the country to do so. At the present time the Chamber had simply the idea of getting together a certain number of wealthy men who were willing to give prizes—prizes to be scrambled for. The schoolmasters in England did not think highly—to put it mildly—of the Chamber of Commerce from the educational point

of view. He had sat on the committee with Mr. Hooper, and he was enabled to say with what modesty the merchants of London sat round the committee table and said nothing when the question of this commercial education was being discussed. It was left in the hands of two or three persons. The Chamber had not yet learned, in this democratic age, how to call together a representative society. If they called together such a committee, it would soon become evident that it was for educationalists to provide, and for the Chamber to say what its members wanted the youths of this country to know; and under proper conditions as to age (and a curriculum not over-complicated, because they could never put a quart of liquor into a pint pot), and under defined conditions, the schoolmasters of England would undertake to provide the Chamber of Commerce and commercial men with the youths they required. But, to do this, that organisation was wanted in England—now conspicuous by its absence—which had enabled France and Germany to do so much.

Mr. J. AUSTIN JENKINS, B.A. (Cardiff), said he should like to say how grateful he was that the subject of commercial education had been given so much prominence in the Congress. It seemed to him that in this country we were in great peril of specialising over much, and in doing this too early in the scholastic career of the scholars, and he thought it would be a bad thing in many respects if this specialisation were allowed to enter too largely into the curriculum, and into the working of the secondary schools. The chief duty of a school was to develop the general intelligence of the child—not so much to give him information as to develop his faculties, to increase his intelligence, to widen his powers of observation, so that when the child had grown in years, and had manifested an inclination in the direction of commerce, or law, or science, or literature, he could bring to bear upon those subjects a mind well developed and trained. It was incontrovertible that as a class, clerks were wanting in general intelligence. They could work the type-writer splendidly, but they had no initiative or resource. Not only was it necessary to develop the general intelligence of those who were to be clerks, but it was necessary to avoid over-specialisation in order to widen the interests in life of business people. Generally speaking, business was exceedingly dull and monotonous. He thought, therefore, that it was necessary for them to give all the attention possible in the schools to the development of the general intelligence, so that a man's interest in life should not be confined to the trade or pursuit for which he had been specially trained, but that to some extent the dreadful monotony which was inseparable from ordinary business life might be counteracted. If the Chamber of Commerce were to start a College of Commerce in this great city, it would do a vast amount of good, directly or indirectly—directly it would do a great deal, indirectly a great deal more. It would be a constant stimulus to Chambers of Commerce throughout the country to take a greater interest in commercial education, and to bring themselves into closer touch with the various technical schools in the country, who were trying to do something in this direction. It would also stimulate the university colleges in this country. Most of the ambitious university colleges, as soon as they had the money, established a faculty of law. They had eminent professors, but very few students, because, after all, there were not many men engaged in the law who wished to know more about the law than was absolutely necessary to advocate a case successfully before a County-court Judge, or a stipendiary Magistrate. He might be very heterodox, but, so far as he could see, it was much more important that their university colleges should establish faculties of commerce than that they should establish faculties of law. Take the case of Wales. In 20 years time they would have a large number of graduates. What were they going to do with them? They could not make all Welshmen preachers or teachers. There was one solution for the difficulty, and that was that they should get the university colleges of Wales to establish faculties of commerce, and get competent men to lecture on commercial geography, commercial law, and kindred subjects, three months in the year at Cardiff, three months at Bangor, and three months at Aberystwyth. They would then do a great service to the world if they could send out men and women from those Welsh University Colleges of Wales who were well versed in commerce. It was important that to some extent each locality should decide its curriculum for itself, and in that connection it was interesting to note that whereas in the Cardiff Technical School they could not get a class together for German, strange to say, Spanish was a popular subject. Why? Because of the large iron trade between Cardiff and Bilbao. That showed that certain discretion should be vested in the hands of the local authorities.

Mr. D. SAVAGE said it would appear from the remarks of some of the speakers that afternoon that commercial education was very much neglected in London, but he was connected with one institution, and knew of others, where classes are not attended by Germans only, but by English young men, who had worked hard in offices all day, and devoted their energies to the study of commercial subjects. He believed that one reason why so few presented themselves at the examinations of the London Chamber of Commerce was because there were so many examinations overlapping one another. He hoped that if any higher school of commerce were to be founded, it would be under the Technical Education Board rather than the London Chamber of Commerce, because it was more the function of the one body than the other. Although the Chamber of Commerce had done much to encourage higher commercial education, yet a body which was called into being in order to devote itself to higher educational matters should be the body to organise a system of commercial education in London.

The CHAIRMAN said he had listened with great interest to the remarks of Mr. Jenkins, but he would venture to suggest to him that commercial education could only be given in a centre of commerce. To teach commercial education at Bangor or Aberystwyth would be absolutely hopeless, and he would advise it to be confined entirely to Cardiff, or, in the case of North Wales, to send the students to Liverpool, which was a real centre of commerce. He thought that any proper commercial education ought to embrace within its scope a department of commercial law, and in that sense he was in thorough agreement with Mr. Jenkins's remarks.

Mr. HOOPER considered the Technical Education Committee of the London County Council could, if it were found desirable or necessary, found and conduct a High School of Commerce, better than the London Chamber of Commerce, as it could call upon the rates for funds, which the London Chamber of Commerce could not do. The Chamber had given a great stimulus to the teaching of foreign languages, in the way that merchants wanted them—not a book knowledge only, but to be written and spoken easily. As to the number of candidates at their examinations, of course they fluctuated, this year there is a large increase, more especially with regard to higher commercial education, and he thought that the London Chamber had given a satisfactory lead in this very important question.

THE PROVISION OF HIGHER COMMERCIAL EDUCATION IN LONDON.

By SIDNEY WEBB, LL.B., L.C.C.,
Chairman of the Technical Education Board of the London County Council.

When in 1893, Professor James reported to the American Bankers' Association upon the provision made for commercial education in the various countries of Europe, he was able, practically, to omit all reference to the United Kingdom, on the ground that nothing of the kind existed there.[*] This statement is, as we shall see, no longer completely true, even if it ever was. But every foreign observer continues to be puzzled by the contrast between the boundless and ever-increasing business transactions of the British Empire, and the lack of provision for the technical training of those who are charged with them. The main cause of this deficiency is, undoubtedly, the ingrained belief of the English business man that there is not, and never can be, any "commercial education" comparable with that which a man "picks up" in the actual business of daily life. The most intelligent merchant never dreams of seeking for his son any special "commercial education": he either sends him to Oxford or pitchforks him straight into his office.

During the last ten years, in particular, this lack of commercial education in England, and the failure ot business men to appreciate the need for it, has been a matter of serious concern to those interested in technical education. Every writer on the subject has bewailed our backwardness.[*]

Since the conference convened by the London Chamber of Commerce in 1887 the subject has been persistently pushed by that body, which deserves credit for its early and unwearied efforts. Other chambers of commerce have since taken the matter up and have set on foot promising investigations.[†] Here and there a town council has fitfully bestirred itself to help elementary evening classes in French and German. But all the attempts have hitherto failed to create an organised system of commercial education in the United Kingdom, or, as it must be added, accomplished anything to speak of in the way of converting the ordinary business man to a belief in the subject.

This failure I attribute largely to the absence of any clear conception of what is required.

I.—Our need is for more Commercial Instruction not better Commercial Education.

"The Englishman enjoys the best commercial education in the world," I heard one eminent German remark. "What he needs is more instruction in commercial subjects." The distinction is fundamental, and the failure to understand it accounts for much of the apathy or hostility of business men to commercial education. Those who push schemes of what they call commercial education do not deny that far and away the best training for a business man is to be gained in business itself. They make no proposal to supersede the merchant's office by the school, or to substitute any academic pupilage for the apprenticeship of the City. Public opinion is only just learning that technical classes are no substitute for the workshop, but only its complement. In the same way, schemes of commercial education are not intended to train the business man, but only to teach him things that he does not, as a rule, pick up in the City. He may do without this knowledge. He may hire someone else to supply it. But, speaking generally, he cannot get it from any other source than a definitely organised educational institution.

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[*] "The Education of Business Men in Europe." A Report to the American Bankers' Association by Professor E. J. James. (New York, 1893, pp. 232.) See also three other reports of the American Bankers' Association, entitled "The Education of Business Men, I, II, III. (New York, 1891-3.) For access to some of the works cited in this paper I am indebted to the courtsey of the Education Department, and the admirable library lately established in connection therewith under the direction of Mr. M. E. Sadler.

[*] See, for instance, the chapter on the subject on "Industrial Education," by Sir Philip Magnus (London, 1888); "Studies in Secondary Education," edited by the Rt. Hon. A. H. D. Acland and H. Llewellyn Smith (London, 1892).

[†] Mr. J. J. Findlay's instructive "Brief Report on Commercial Education in England," made to the Sheffield Chamber of Çommerce, 1891; together with the Report on Commercial Education presented to the Associated Chambers o mmerce in 1887.

II.—Commercial Education must be divided into three distinct grades.

There is, first, the education of the youth before he enters business life. There is, second, the provision of opportunities for evening instruction for the young clerk. And third, but perhaps most important of all, there is what may be called higher commercial education, required by the officer of the commercial army, if not by every ambitious member of the rank and file. Unless we distinguish clearly between these three grades, we shall all be at cross-purposes.*

III.—We need more variety in our secondary schools, including some which should prepare boys deliberately and purposefully for business careers.

This is part of the problem of the organisation of secondary education, and I propose only to make a suggestion and pass on. In spite of all the improvement in middle-class schools, since Matthew Arnold bewailed their inefficiency, they still seem to me to suffer from not being quite sure what they are aiming at. I do not pretend to know what school curriculum will fit boys most successfully to be clerks or merchants, civil engineers or bankers, actuaries or chemists. Such a curriculum would perhaps have no very obvious connection with their future work. But I cannot believe that the best curriculum in each of these separate cases is identical with the best curriculum for all the rest, and for a university career. The idea that a "good general education," of a literary or classical type is an adequate, if not indeed the best, preparation for every kind of career, sounds like a survival from the middle ages.

Without for the moment touching on the question of university curriculum, we may infer that there should, at any rate, be a clear distinction between an educational course which ends at 15 or 16, and one which is intended to be continued up to 22 or 23. Yet so strong in England is the tradition that education is one and indivisible, that the vast majority of "middle schools" go the same way as the "high schools," habitually working up to the same system of examinations, whether emanating from Oxford, Cambridge, or London Universities, or the College of Preceptors, and pursue accordingly much the same curriculum with merely minor variations as to the relative time allowed to the several subjects. I speak entirely as an outsider with no knowledge of the needs and organisation of secondary schools. But this muddling up together of "gymnasium" and "realschule," of "lycée" and "école commerciale" cannot but be detrimental to both varieties. There must be room for some schools, which need not be called commercial schools or bear any other badge of supposed inferiority, but which should reject all connection with the university, which should altogether exclude its influence, which should decline to follow its traditional curriculum, and which should arrange a course of studies deliberately based on the needs of boys who will become clerks in City offices at 15 or 16.*

This, I know, will be misunderstood, as involving a too-early "specialisation," the loss of culture, and so forth. What I am advocating involves no "narrowing" of the curriculum. It implies, on the contrary, the inclusion of much more culture, the taking of a wider view of existence, a great deal more of "seeing life truly and seeing life whole," than the average secondary schoolmaster, experienced only in one narrow line, is as yet either capable or conscious of. One of the greatest difficulties in the way is, indeed, the lack of adequately trained teachers. But it does mean the abandonment of scholastic prejudice and tradition in favour of a purposeful adaptation of means to ends. It means putting a great deal of deliberate contrivance into the business of making the most of three or four years of a boy's life.

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* The French law of 1888 on Technical Education recognised three grades of commercial education.

* It is the crudest of misconceptions to suppose that such a curriculum would be made up of shorthand and book-keeping, or the playing at commercial transactions, once tried (and, I believe, abandoned) in some German "commercial institutes." The inimitable Stock Exchange school, described in R. L. Stevenson's "Wreckers," is scarcely a wilder parody.

I do not pretend to suggest what form this contrivance will take in each case—how to produce the greatest possible efficiency without impairing the whole man. There is evidenrly much to be learnt from abroad. Anyone reading the prospectuses of the "écoles supérieures de commerce" of the principal French towns—and I know nothing more of these institutions—will be struck by their deliberate choice of subjects, with a single eye to turning out the best, and therefore the most highly cultivated, business man—the complete absence of Latin and Greek, but, on the other hand, the very high development to which other teaching is carried.*

The London Chamber of Commerce has, for ten years, been striving in this direction. But its examinations in commercial knowledge, carefully elaborated as they are, cannot compete in popularity with the examinations emanating from the Universities, or from the College of Preceptors, which drag the school curriculum in another direction. The experiment of providing schools giving an education deliberately and exclusively directed to turning out the best possible (and therefore, let me repeat, the most highly cultivated) commercial clerk, or business man, will probably have to be tried by some public authority, able to afford to disregard both scholastic tradition and parents' snobbishness. We do not want all our schools to be of this type, but there might, at any rate, be one such. Such a school, for boys between 12½ and 17, was established as long ago as 1863, by the Paris Chamber of Commerce itself, and has ever since continued to be most successfully managed by one of its committees. It has now over 500 pupils, drawn almost entirely from middle class "business" households, residing in the very heart of Paris.†

IV.—The special commercial instruction of the young clerk is part of the work of evening educational institutes. What is most needed here is the employers' co-operation and encouragement.

London is pre-eminently the city of clerks, containing not only a far greater number than any other centre, but also, probably, a greater proportion to the total population than elsewhere. For their evening instruction in French, German, Italian, Spanish, and Portuguese, as well as in arithmetic, book-keeping, typewriting and shorthand, there is now fairly good provision made at more than a score of public institutions in different parts of the metropolis, which number in these subjects alone probably 10,000 separate students.*

But 10,000 students represents only a small proportion of the young men and young women in London between 15 and 25, and I fear we must conclude that the great majority do not trouble about anything but cricket or bicycling after their office day. This is where the German clerk gets ahead of us. "I would much prefer English clerks," said the head of one of the very largest firms in the City, "but I find my office full of Germans. The English clerk takes no intellectual interest in his work, and seems to give his mind to sport."

If employers made a point of letting it be known they liked their clerks to attend evening classes, and considered the fact in their promotions, the 10,000 students might soon be multiplied fourfold.

V.—In the teaching of modern languages, in particular, England is behind both Germany and France in method and variety.

All competent witnesses seem to agree that English teachers of foreign tongues, whether in day schools or evening classes, have much to learn from Germany in pedagogic method. All testimony points to London being far behind both Berlin and Paris in the number of languages actually taught. There is one secondary school in London, and I believe one only, where Spanish is taught (the Whitechapel Foundation School). England does more trade with the East than any other country, but the young city clerk or commercial traveller who sought to learn modern Greek, Arabic, Turkish, Persian, Malay, Armenian, Chinese, Japanese, Annamite, Hindustani, or Tamil—to say nothing of Russian, Dutch and Norwegian—would find considerable difficulty in getting instruction at low fees and convenient hours. As a matter of fact, the School of Oriental Languages, promoted by the Imperial Institute in conjunction with University and King's Colleges, fails to secure more than an infinitesimal number of students, and these few are, I am informed, almost entirely non-commercial. I understand that in all the languages that I have named, together with others, there are successful classes in Paris, Vienna, and in Berlin, not only at one, but in most cases at several different centres, and sometimes absolutely free of charge.*

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* See, for a complete list of these and other schools, "The Annuaire de l'Enseignment Commercial et Industriel," par Georges Paulet (Paris, yearly), pp. 700; and "L'Enseignement Commercial et les Ecoles de Commerce en France et dans le Monde entier," par Eugène Léauty (Paris, 1886), pp. 778.

† "Notice on the Commercial Instruction organised by the Paris Chamber of Commerce" (Report to the Chicago Exhibition, 1893), Paris, 1893, pp. 192. "Industrial Education," by Sir Philip Magnus (London: 1888).

* See the "Fourth Annual Report of the Technical Education Board of the London County Council," London, 1897, 62 pp. This total does not include the evening continuation classes of the School Board for London, which teach typewriting, shorthand, elementary French, &c.

VI.—*But our most striking deficiency has hitherto been in higher commercial education—the provision of higher instruction in commercial subjects for the business man.*

Let us see the sort of technical education a young Frenchman has open to him, as a preparation for the actual training of business life. Besides founding in 1863, the "Ecole Commerciale" already described, the Paris Chamber of Commerce purchased in 1869 an old private institution, and transformed it into the present "Ecole Superieure de Commerce," for pupils between 16 and 20. Here the young business man gets an exclusively commercial education of the highest school type, to which I believe we have nothing corresponding in this country. But beyond this again stands the "Ecole des Hautes Etudes Commerciales," which is intended to give pupils between 19 and 22, who have already completed their secondary education, two years special training in the subjects needed by the banker and merchant. It is, in fact, an institution of University rank, exclusively devoted to commercial subjects. Its magnificent premises, situated in the very heart of Paris, have cost over £100,000, and are only intended to accommodate 300 students.

The course of instruction includes besides handwriting, arithmetic, book-keeping, and two foreign tongues, economic and commercial geography; history and principles of commerce; political economy; elements of the commercial law of the principal countries, their customs, tariffs, and commercial systems; factory legislation and similar regulations affecting industry; and the study of means and routes of transportation throughout the world.*

I need not say that Berlin in no way falls behind Paris in all these respects; and the chief provincial towns of France and Germany offer educational opportunities of the same kind, though, of course, on a smaller scale.†

VII.—*The London School of Economics and Political Science as a High School of Commerce.*

London has now got the beginning of a "High School of Commerce," in an institution started quietly in 1895, and already affording an experience of great interest. The London School of Economics and Political Science was founded by a little committee, who believed it possible to create a demand among men engaged in the practical business of life, for instruction in the concrete applications of economics to the affairs of commerce, finance, and public administration. The London Chamber of Commerce had already tried the experiment of inviting Dr. Cunningham to give a course of lectures on Commercial History, which had been well attended by attentive audiences of young business men. That experiment was followed up, systematically extended to other subjects, and made part of an organised course of education under the directorship of Mr. W. A. S. Hewins, M.A., of Pembroke College, Oxford. Through the intermediation of the Technical Education Board, the new "school" was placed in communication with the London Chamber of Commerce, which readily lent its premises for some of the work, and in every way promoted the idea.

The school is now completing its second session, during which it has had over 400 separate students, men and women, from 17 years of age upwards, drawn mainly from two classes. The greater number belong to the class of clerks, managers, and young business men, engaged in banking, commerce, insurance, railway administration, or the Government service (national or municipal). The minority belong to the student class, including between sixty and seventy post-graduates, specialising on economic or political science, and representing, besides the British seats of learning, Universities from Moscow to Chicago, and Buda-Pesth to Tokoi. Among the "business" students, with whom I am more closely concerned here, are a few "principals," bankers and merchants, actuaries, and insurance-brokers, railway managers, and heads of important public departments—but the majority are naturally young men in subordinate positions, for whose convenience the bulk of the work is done between 6 p.m. and 9 p.m. One or two business houses have paid the (very low) fees for their own clerks, and this course has been adopted by two railway companies, the Great Western and the Great Eastern, whose example will probably be followed by others.

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* See, for instance, "Das Commercielle Bildüngswesen in Oesterreich-Ungarn," von Franz Glasser (Vienna, 1893), 422 pp.

* "Notice on the Commercial Instruction organised by the Paris Chamber of Commerce" (Paris, 1893); "L'enseignement Commercial et les Ecoles de Commerce," par Eugène Léauty (Paris, 1886).

† "Das Kaufmännische Fortbildungs Schülwesen Deutschlands," von Harry Schmitt (Berlin, 1892), pp. 211; "Käufmannisches Fortbildungs Schülwesen," edited by Dr. Stegemann, vol II, pp. 436 (Brunswick, 1896).

The curriculum of the school includes commercial history and geography; the principles and practice of banking, currency, and the foreign exchanges; commercial law; the economic and industrial history of the principal countries; the history and incidence of taxation, including customs' tariffs; the principles and practice of railway administration at home and abroad; the history and present positon of factory legislation and trade unionism; the methods and interpretation of statistics, with special reference to commercial, financial, railway, and administrative statistical returns; together with systematic courses in economics. There are also departments for political science (including the study of foreign constitutions and municipal government) and palæography (for historical students). Among those who have lectured or taken classes at the school may be mentioned the Right Hon. Leonard Courtney, Sir C. P. Ilbert, Mr. Westlake, Q.C., Professors Foxwell, Cunningham, Gonner, and Edgeworth, Mr. W. M. Acworth, and Mr. MacKinder.

In connection with the school, there has been established a unique specialist library, the British Library of Political Science, which has united in its subscription list statesmen and economists, great officials and business men of all parties and shades of opinion, including the Duke of Devonshire, Lord Rosebery, Mr. Balfour, Mr. Chamberlain, Professor Marshall, Mr. Lecky, Lord Welby, the Archbishop of Canterbury, and Cardinal Vaughan, with such representatives of the business world as Sir Samuel Montagu, Sir John Lubbock, Mr. F. D. Mocatta, Mr. T. F. Blackwell, Sir J. Blundell Maple, Sir J. C. Dimsdale, and Mr. Spicer. The rapid growth of the institution has been made possible, partly by private donations, partly by the cordial aid and generous support of the London Chamber of Commerce and Society of Arts, the Worshipful Company of Clothworkers, and the Technical Education Board. There is every prospect that its excellent new premises at 10, Adelphi-terrace, Strand, will, by next session, already be too small for its work.*

VII.—Higher Commercial Instruction must take the form of concrete application to each branch of business, and must, therefore, be highly specialised.

The two years' experience of the London School of Economics and Political Science, together with that of the London Chamber of Commerce, the Institute of Bankers, and some other bodies, affords some interesting lessons.

(*a*). Higher commercial education in England must, like the technological instruction of artizans, be not a substitute for the training of the office and the workshop, but merely its complement. Hence it must be given to men already engaged in business, and, therefore, at hours convenient to them. If there is to be a "higher commercial" side to the new London University, it must be for late afternoon or evening studies.

(*b*). It is useless to appeal to the clerk or the business man *as such*. The great world of clerks and business men, who seem to the academic student to form a single class must be broken up. The merchant, the shipowner, the cornfactor, or produce broker, and their *employés* may, perhaps, form one large group. The insurance clerks, actuaries, and public accountants, who, in London, must number some thousands, require something quite different. The great army of railway officials, from the assistant traffic managers down to the youngest clerk in the Railway Clearing House, need yet another kind of instruction. The clerks in banks and finance houses have specialised wants of their own. Finally there are the tens of thousands of clerks and officials employed in the various branches of public administration, for whom a distinct curriculum is provided by both Germany and France. Probably there are several other distinct groups needing separate treatment.

So long as we offer these groups indiscriminately "Commercial Education" in the lump, they will, quite rightly, pass by on the other side. But put before any one of these classes a definitely specialised curriculum, based on the actual needs of the calling, and experience proves that the abler, the more industrious, and the more ambitious of the young men will begin to take an intellectual interest in their occupation, and desire to learn something more about it than they pick up in the office.

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* This institution is recognised by foreign authorities as a "higher commercial school:" see the description of it in "Kaufmännisches Fortbildungs Schülwesen" (Brunswick, 1896), vol. II, p. 356.

(*c*). The fees must be low ; the young clerk is poor. Experience shows that, though elementary French and shorthand classes pay their way, "Higher Commercial" subjects, *narrowly specialised as they must be*, need to be heavily subsidised and endowed. This, indeed, is the case with regard to all education of University rank.

IX.—What Higher Commercial Education in London now needs is encouragement, endowment, commercial support, and University recognition.

England has not, as yet, done much for higher commercial education in the way of money or public encouragement. In French and German towns, the leading business firms subscribe largely to the commercial schools, present them with endowments and scholarships, and habitually send to them for clerks. The Government and the municipality vie with each other in their subventions. The Universities hold out a hand to the higher commercial schools, and recognise, under one name or another, their subjects as qualifying for degrees. The time has surely come for this country, and for London in particular, to follow suit. What is required is :—

(*a*). For all the principal establishments to urge their junior *employês* to attend such lectures and classes as have been described, and, if possible, to encourage them by paying the fees;

(*b*). For the railway, banking, insurance, and shipping companies to take a similar course ;

(*c*). For private donors to endow lectureships and scholarships in the particular subjects they are interested in ;

(*d*). For the technical instruction committees of county councils to remember that commercial education is an important branch of technical instruction according to the Act.

(*e*). For the new University for London to recognise the importance of these studies by creating a special faculty of commerce under one designation or another ;*

(*f*). For the Government to enlarge its Parliamentary grant to university colleges, by including a special sum for institutions giving higher commercial education.

THE PRESENT STATE, CLAIMS, AND PROSPECTS OF COMMERCIAL EDUCATION.

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I propose to glance at some of the features which characterise the respective forms of commercial education afforded by the leading countries at the present time, to consider some improvements which await adoption, and, in particular, to inquire what should be done by that country whose privilege it is on the present occasion to provide a place of meeting for the International Association, one of whose objects it is to stimulate attention to this subject.

Congratulation may well be offered to that European State whose political influence is now so conspicuous that, after being the first to witness definite provision made within its borders for commercial, although backward in other forms of education, it should by recent action have supplied valuable comment on the unsatisfactory position of England in this matter. Certain "British interests" will doubtless at the present Congress engage attention, the rather because England has so long been paramount in commercial enterprise, and has still longer presented an object-lesson to other countries in regard of political institutions, which help so much to explain its economic success. The British *Board of Trade Journal* has lately recorded decided advance made by Russia in the reorganization of its commercial schools; by a country which was the pioneer, one century and a quarter ago, in work that France took up half a century later, to be followed by Germany and other great powers, by the United States of North America, and last of all, we may hope, by Bonaparte's "*nation d'épiciers*." Until 1894, Russian commercial instruction was confined to intermediate schools, without inspection, but since that year it has been placed under the superintendence of the Ministry of Finance, and drastic improvements are in process of realisation; lower commercial instruction is being recognised, and classes on the higher plane are being established, whilst the development of commercial museums receives careful attention.

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* "What then is lacking in this economic (commercial) education to make it in demand? It lacks only the sanction which crowns university studies. It is not sufficient to open the doors of entrance into the schools of commerce, one must also open the doors of exit. Nothing further can be done until the legitimate demands in favour of economic instruction shall be met, and it shall be placed on a par with classical education."—"The Education of Business Men in Europe" by Prof. E. J. James (New York, 1893), p. 155. In all the Belgian State Universities, by Royal Decree of 19th Sept, 1896, there is now a degree in "Commercial and Consular Sciences," forming a branch of the faculty of law. "Moniteur Belge," 2nd October, 1896.

Little advance has been made by our nearest neighbours since the publication, eleven years ago, of M. Léautey's *L'Enseignement Commercial.* Then already *bourses de voyage*, or travelling scholarships, had been founded by the French Government, which has since taken steps to procure employment of the holders by the consuls of the Republic. On the other hand, a notable series of articles entitled "Nos Fils," in the *Figaro*, last year, by M. Hugues le Roux, which culminated in that appearing on December 2nd, 1896, show that the French mercantile community must bestir themselves not a little over the transformation of modern commerce into a science. Pupils of the Paris commercial schools still continue to resort to the Antwerp Institute for the completion of their studies.

In the German Empire the commercial schools have still to re-assert their unsatisfied claims to distinct recognition by the respective Governments, only one of which imposes regulations as to the efficiency of teachers of Commercial Science, so that a difficulty in keeping up the supply is felt from time to time. Need is also felt of greater uniformity in teaching, a subject which, it has been announced, is to engage the attention of a Commercial Education Congress during the present summer. The Leipsic School, which is now the property of the local Chamber of Commerce, keeps well to the front; there within the last year special provision has been made for the instruction of foreigners. This school continues to be well manned.

The Bavarian Government Regulations of 1895 for the teaching of Commercial Science require, as preliminary to entrance for the examination prescribed for intending teachers, (1) production of a leaving certificate from a recognised Commercial School, a *Realschule*, or from the commercial division of a Technical School; (2) proof of one year's study at a Technical High School or University, of Economics, Economic History, and Geography, and (3) evidence of practical work done in a counting-house during at least one year. The examination, written and oral, comprises (1) an essay designed to bring out the general education of the candidates; (2) Economic Geography and History; (3) Mercantile Arithmetic and Algebra; Book-keeping and Correspondence; (5) Commercial Law; and (6) Economics. The candidate must discourse before the Commission on a topic prepared twenty-four hours beforehand, undergo oral examination on such discourse; and, finally, display his teaching capacity in a technical intermediate school at Munich.

Belgium shows unabated energy in fostering its trade interests. The Institut Supérieur de Commerce at Antwerp has become further prominent as a centre of educational activity. A three years' instead of a two years' course was inaugurated in the autumn of 1896, specially in promotion of the usefulness of the Consular service of this small but enterprising State, whose merchants rely upon the guidance of skilled officials; the training of the latter, accordingly, has become a matter of vital importance in these days of international trade competition.

In the Austro-Hungarian Empire the good work done by the German Academies at Prague and Vienna is well maintained; in particular the fine museum of commodities and instruction in that department at the capital are jealously looked after.

Genoa continues to lead in the commercial education available in Italy, and teachers of its higher institute are amongst well-known contributors to the literature of Commercial Science.

In the United States of North America there continue indeed to be several "commercial" and a multitude of so called "business" colleges, but the difference between them is slight, and commercial theory is still overshadowed by the empirical treatment of these studies. The New York Bankers' Association has done good service by publishing the report of a gentleman commissioned by it to visit European Institutes with the view of bringing present requirements into notice.

How far has Great Britain awakened to her concern with this matter? The answer must be one not very encouraging. One mercantile institution, however, it must at once be said has not relaxed its efforts, since about the time of the first Congress of this Association, to keep the claims of commercial education before the public attention: the London Chamber of Commerce has not been remiss. Year by year, through its instrumentality, has our subject figured in the agenda of the meeting of the Associated Chambers, and in every possible way, short of founding a commercial school or institute, has this body promoted the cause. It has promulgated a scheme of junior, and another of senior commercial education, instituted yearly examinations, raised money for prizes and scholarships, of which the last additions are those of the Salters' and Drapers' Companies, in aid of residence abroad, and, in conjunction with the Society of Arts (whose examinations begun forty years ago, on commercial subjects, remain in full vigour), procured the grant by the London County Council Technical Education Committee of some £1,200 for each of the two last years to the London School of Economics, whilst seeking to extend to the provinces the advantages afforded by its own examinations. The London County Council has also subsidised the commercial classes of the City of London College and the Birkbeck Institution. The Polytechnics in general offer certain classes helpful to commercial clerks.

Owing to the feeble support given by ordinary schools, examinations for commercial certificates instituted by the Universities of Oxford and Cambridge and that conducted for the Manchester Chamber of Commerce by the Victoria University have collapsed, but the Oxford Local Examinations Delegacy has for the present year provided for certain commercial subjects in its general programme, which thus receive some renewed countenance.

The Scotch Education Department has provided to a slight extent for such subjects in the examinations for its leaving certificates, but the schools in general pay little heed to this part of the syllabus. The Irish Intermediate Education Board has gone somewhat further, with apparently more support from teachers.

The examinations of the Institutes of Bankers and Chartered Accountants exhibit a high standard, and other public bodies are moving in the right direction.

To speak now of educational facilities outside the metropolis. Technical instruction committees, administering funds provided by Parliament and distributed amongst the various counties of England and Scotland, have here and there established classes, chiefly for modern languages, book-keeping, shorthand, and typewriting; but what little effective supervision there has been was exhibited mainly in the West Riding of Yorkshire, whose general committee, it is believed, have discharged their duty in this respect better than any other like body. "Commercial subjects" have usually been co-ordinated with dressmaking, cookery, nursing, ambulance, elocution and the like! The Manchester School Board, however, deserves a word of praise for the excellent start which it has made; and it is to be congratulated on having secured the services of a gentleman as Director who is at the same time a chartered accountant and able, energetic teacher.

Really good work has been done by some schools and institutions not "holding the purse." Thus the Union of Lancashire and Cheshire Institutes has stimulated commercial instruction by a fine system of annual examinations; the authorities of the Birmingham and Midland Institute have not neglected these subjects, although receiving scant assistance from local traders; and at Liverpool the Shaw-street Schools, under new management, have entered upon a career of further usefulness; the "Middle School" corresponding closely tc a German *Real Gymnasium* modified by features of a *Real Schule*, and loosely to a Belgian *Athénée*; the "Commercial School," to a Belgian *Ecole moyenne*.

Few institutions seem to avail themselves of Whitehall grants for subjects such as modern languages and book-keeping. The writer has taught for one which did.

In Scotland these subjects meet with appreciation at the Heriot Watt College in Edinburgh, and from the School Boards of Leith and Glasgow, whilst good service is being rendered to commercial education by the Glasgow Athenæum. An attempt has been made at the Blairlodge School, Polmont, to approximate to continental methods by its "commercial bureau," which has been favorably reported on to the Scotch Education Department, by Mr. R. C. Millar, C.A. (1888), The circular issued by the Scotch Education Department in June, 1897, on the constitution of and expenditure of money by secondary education committees tends in the direction of advancing commercial education in the north.

In Ireland, even to the extent to which certain intermediate schools avail themselves of the general examination syllabus above referred to, the whole thing is in its infancy. Belfast does nothing worthy of its position as a commercial centre; Dublin still less.

Although the claim of commercial education to be organised on a proper basis has been repeatedly urged by prominent men on public platforms, and Professor Wolfrum, of the Leipsic School, in his recently issued "Bericht" for 1896-1897, remarks that in England "there is a rush to make up for lost ground;" the words of M. Léautey in 1886 remain literally true: "il n'existe pas d'écoles de commerce proprement dites en Angleterre, en Ecosse, et en Irlande." Nevertheless, as he has also said, "par necessité aussi les Anglais ouvriront avant peu des écoles de commerce."

After the passing of the Technical Instruction Act, industrial education, of course, claimed first attention, and that it has received in good measure. Even in commercial centres such as London and Liverpool, technical institutes have spent the bulk of their funds over science and art classes. There was a feeling, referred to by the Duke of Devonshire in his recent reply to Lord Norton's question in the House of Lords, that, as the Chairman of the Royal Commission on Secondary Education has put the case, the money has been "spent in an ill-directed and ill-organized way." Many who have been behind the scenes, as members of committees or as teachers, have shared that belief. Time was needed for experience to be gained, and secretaries have not always had their own way. The notion has been dominant that the great thing was to instruct workmen. As it is, few of the class contemplated have lent themselves to the process. It is now increasingly seen that employers above all should be specially educated; the claims of the commercial management of industrial undertakings have been strangely lost sight of during these seven or eight years. It can be of little use developing the productive powers of a people if the means of circulation be neglected, if we do not look after those factors trade and transport, which impart the character of "productive" to so much that is looked upon as part of the national wealth. In other words, very much more attention must be given to the *commercial* side of technical education. It is from a better educated mercantile community that the leaders of industry must draw their inspiration; such is the ever repeated opinion of all the consuls of every European country in the advice tendered by them to the Foreign Department of the State represented, of British Consuls no less than others. The conditions of international trade-rivalry have accordingly determined the course taken by economic instruction in various parts of the world.

Schoolmasters, upon whose co-operation the London Chamber of Commerce placed too much dependence, have largely fostered the really effete and always absurd idea that a youth can be taught in counting houses all that he needs to know of business. Apart from the impossibility of training a clerk in an office for anything beyond a special department of work —to which the typical schoolmaster assumes he will settle down for life—there is the striking fact now-a-days that British merchants have failed to maintain in the same way as formerly their great lead in the world. Enterprise and energy are good in themselves, but must be wisely directed. Competition governs modern life, and we must learn how to meet it; how not only to act defensively but offensively. Teachers feel pressure within their own sphere, and there have to yield to new ideas, special training in the theory as well as practice of education being now called for. Common ground is occupied by ordinary and by economic educationalists in maintaining that education on a broad basis should precede specialisation. To disparaging remarks about putting a "bread and butter" value on education, the reply is at hand that accredited upholders of commercial education insist not only on preservation of the inherently educative value of "*Brodstudien*" in the hands of teachers, but on recognition of the fact that the old *classical* education which, it was supposed, alone could develop "faculty," has much depended within the memory of man on pecuniary considerations, although this this fact may shrewdly be kept in the background. The race for money prizes at the universities, and good places in competitive examinations generally grounding success in life, on the part of the great schools remains as keen as ever; so stimulative is the thought of the real goal even there, the consideration all round of what will "pay" being dominant. The "commercial" spirit has infected every profession, unless we except army, navy, and diplomacy; and commerce itself has become one of the professions, as aptly shewn in the *Figaro* articles. Such is the irony of events. Mr. Pollard, head master of the City of London School, in his essay on Commercial Education gives currency to the commonplace saying that "the commercial man seeks what is of use," which, if it mean that he seeks nothing more, is worthy only of a sordid tradesman, and is a very questionable proposition as applied to the recognised leaders of the British mercantile community. M. Léautey's saying "Les

Anglais naissent commerçants" might have served for times gone by; so also his remark that "il semble que l'enseignement classique soit nécessaire pour idéaliser quelque peu leur esprit." There is no need to explain the past, but we have to face the future, and rest on their oars the Britons cannot. Even traditional methods of classical education are being discarded, and educationalists have now to own that it is not so much the subject but the way in which it is taught that produces intellectual result. Mr. Goschen gave voice to a common sentiment regarding average boys at the time of their leaving any of the great schools, when he complained, in an academical address given north of the Tweed, of their not having any intellectual interest, On the other hand Mr. Pollard has opportunely stated his belief that commercial education on the lines indicated in his Essay would tend to raise the general level of intelligence. Such has been the actual experience of the present writer in dealing with boys instructed in classical and commercial subjects concurrently. A good method with any of the new subjects will do more educationally for boys with no special aptitude for the old culture than the best of the now discredited methods of secondary schools.

Some advocates of higher commercial education, such as an eminent English ecclesiastic, have from time to time used language tending rather to dishearten than to encourage speedy action. Difference of opinion has been expressed as to whether it is money that is most wanted, or teachers, or students. Whilst Cardinal Vaughan, who did good service at Salford to this movement, supposes teachers and text-books to be practically non-existent, Mr. Sidney Webb finds the principal drawback in the indifference of employers, and consequently of their employees—a conviction shared by the present writer, whose correspondents at various centres testify to the apparent jealousy on the part of the former, prejudicial to clerks who might acquire greater knowledge than themselves. Some, nevertheless, employ foreign clerks already in that position of vantage! Very different is the spirit manifested by mercantile communities in other lands, which have with their own resources founded commercial schools (*e.g.*, those at Moscow, Paris, Leipsic, Antwerp). Then, as regards the clerks themselves, Mr. Bryce and others have sounded a warning note against over-indulgence in sports, for which there is, we suppose, no sufficient corrective at present.

It is the writer's belief, from acquaintance with *teachers*, that there is already a sufficient nucleus for a proper start. A certain number of the teaching profession are competent to direct higher commercial education; some of whom have had practical acquaintance with business, whilst others, after enjoying an academical training, have already done good work under technical instruction committees, if not also in commercial schools abroad, where the services of Englishmen are ever in request. There are many Continental teachers of Commercial Science who have not had like advantages; and of those who are successful instructors the teaching ability was no better accredited in the first instance than that of British chartered accountants, who yield to none of their own class abroad in skilled knowledge of any requisites, short of actual pedagogic training, for taking part in commercial education. Already Manchester and Edinburgh can here give a good account. The rigidity of regulations abroad as to proved teaching capacity is almost universally relaxed, as we have seen, in regard to commercial schools. Studying methods employed in continental schools would be helpful to Britons later on; but we have our own system of business and conditions of work to consider, and, it is believed, have more to teach our foreign brethren than they have to communicate to us: that is the impression derived by the writer from his own observation. It would be disastrous, for instance, to remodel British methods of accountancy instruction on those in vogue abroad. This does not exclude the partial employment of foreign teachers in British Commercial Schools of the near future, in like manner as the Antwerp Institute commands the services of an Englishman on its staff, and the Leipsic School those of another. Foreigners will always be attracted hither by better remuneration, but at present there is no scope for them. Of the training of English teachers of Commercial Science which, it is hoped, will be placed on a better footing than is that of their colleagues abroad, we shall have a word to say in its place.

The question of text-books is one which admits of ready answer. With the single exception of the study of commodities (denominated in German *Warenkunde*) the scholastic treatment of which, indeed, London merchants deprecate, and in respect of which publishers afford no encouragement, English readers are already provided with manuals better than those of any other country, and this whether we think of elementary or of advanced text-books. Will anyone venture to query this in regard to commercial mathematics, book-keeping and accountancy, treatises on banking — in which the British have absolutely nothing to learn from abroad — commercial geography and history (witness the notes of the late Professor Roscher in his "System der Nationalökonomie") or, in particular, economics and ethics, commercial law, and, we hesitate not to add, modern languages? British economists on the scientific, British accountants (the best in the world) on the practical side have been pioneers in commercial science; and need it be said that our people, while willing and glad to learn in respect to teaching method, have more resources where geography is concerned than any other? There is now a body of skilled British teachers of European and Asiatic languages who, after residence abroad, are rapidly developing method in oral instruction and as writers of class books. Recent English text-books in more than one branch, as the writer has reason to know, have since 1890 been adopted in commercial schools of more than one foreign country, or are being translated into German, French, &c. We venture to predict that, if such schools be established in Great Britain before the close of the century, the year 1900 will not dawn upon us before foreign teachers of the commercial sciences will have looked to this country for that guidance for which, too many suppose, we should look to them, whilst foreigners also will be resorting to our academies for knowledge which they fail to obtain elsewhere. Whilst engaged upon this paper, the writer has been requested by a foreign correspondent to recommend a Commercial School, of the type with which the latter is familiar, in London or the Provinces to which he could send his son, 17 years of age, for instruction preliminary to office work at home, and of course has been obliged to reply that such institutions are unknown in our island. It is strange that, in such a state of things, only one English youth, from Manchester Grammar School—with a scholarship granted by the County Council of Lancashire—now represents this country among the pupils of the Antwerp Institute, and that at Leipsic only three are at present registered as from this side, none of them of purely British extraction.

It remains for us to consider the organization of schools and colleges, their equipment, inspection and examination, which, however, must be done very briefly, further remarks being reserved for a work upon which the writer is now engaged for early publication. In the absence of endowment by men of the stamp of Mason or Whitworth we must, it is conceived, look to the funds which Parliament, in pursuance of early prospective legislation, may place at the disposal of county or local authorities for discretionary creation of schools and colleges, in the exercise by them of powers like those outlined in the Bill submitted to the House of Commons in 1896. Of the means to be adopted for raising money by rates, &c., we cannot here speak. The writer may express his settled conviction that the establishment of special schools is of primary importance, entirely concurring in the opinion unanimously expressed by Continental correspondents, who regard the start so far made and views commonly expressed in this country as half-hearted, surprisingly unpractical, and unsatisfactory from even the educational point of view. The remodelling of some of our existing secondary schools after the pattern of Belgian *Athénées* would be of some use, and anything would be better than the present state of things; but to rely on infusion of economic instruction into ordinary school education would be simply disastrous. This is said with regret that we cannot here follow the views of Bishop Percival or of Sir Philip Magnus, expressed ten years ago. There is no fear of "liberal" education being swamped by specialised "commercial" instruction if schools are founded after the pattern of the Leipsic *Handelslehranstalt*, where, according to the last annual report "by far the greater part of the school hours is devoted to instruction in subjects of general culture," whilst Academies like the Institutes at Antwerp, or that at Vienna, which are still missed in the German Empire, supply the needed guidance for Commercial Colleges in this country. The real danger lies in too close adhesion to the recommendations in the report submitted to the Associated Chambers of Commerce in 1886, shortly followed by those contained in Sir P. Magnus's magazine article on "Schools of Commerce"—which the present writer regards as rather more satisfactory—with the result that an ineffective instalment is accepted for the time being in schools of the ordinary type. We need only instance Mr. Pollard's remark that deciphering of German copy is a subject he "would wish never to see introduced into any school." All depends on whether thorough-going commercial schools must await foundation, while Continental nations allow ever less grass to grow under their feet.

To an Organized Commercial School no pupil should be admitted under fourteen years of age, and only after passing an examination somewhat less advanced than the present Juniors' examination conducted by the London Chamber of Commerce which, not falling far short of the London University Matriculation, is calculated to suit boys aged about sixteen. Encouragement should be given by scholarships to pupils from elementary or higher primary schools, who have passed at least the sixth standard, with knowledge of some specific subjects provided for in the Code, which bear on commerce, to enter a secondary Commercial School. This should have a junior division or lower school in which the education given would be carried on further, so as to qualify for such an examination as that for juniors under the Associated Chambers' scheme. A pupil, having passed that, might be sent up to a senior division or upper school; but if unable to continue giving whole time to school work should be able to keep up his studies by attendance at extra courses conducted by the school staff in the early morning or in the evening,—the time of his attendance being at his own option. The difficulty will be felt here, as it still is in Germany, in prevailing upon parents to leave their sons long enough as day pupils; but this might be overcome by the continuation of scholarships to the best pupils. There should be a library, museum and laboratory for the use of the whole school.

There should further be established at all the leading commercial centres a College of Commerce, of university rank, of which pupils of the secondary school might enter as from about the age of eighteen, for a two years' course if for full time, otherwise for an indefinite period as an evening-class student.

The aim should be that every pupil on leaving an Organised Commercial School from the senior division should have attained the standard contemplated by the senior commercial scheme of the Chamber of Commerce, so as to take a leaving certificate of the value at least of the "*Certificat d'études moyennes*" granted at the Belgian *Athénées*, by the sole aid of the instruction given in the school itself.

The curriculum of a Commercial College, which would amongst other things provide special instruction for Teachers aided by training scholarships, should be in view of a diploma like that of the *licencié ès sciences commerciales* granted at the Antwerp Institute, one portion of the syllabus relating to material knowledge; another, which would be optional, in the teaching of mercantile subjects.

The examinations of both school and college should be regulated by and conducted under the supervision of the central authority. The special examination for teachers should be on the lines of the Bavarian regulations, which should comprise a Department having special control of this branch of education, unless the legislature, approximating to the precedent set by Russia, assign such functions to a newly-created Department of the Board of Trade. There should be a staff of chief inspectors, under whom the officers appointed by the local authority, according to whose reports grants would be made by it, should act as assistant inspectors.

The respective curricula which the writer conceives to be suitable to such schools and colleges will be discussed by him in a forthcoming work, in which he will submit model time-tables and offer suggestions on teaching method. Here he will but remark that teachers in general must agree with Bishop Percival that the course of study proposed by the Chambers of Commerce for schools is too complex, and insufficiently practicable, although affording valuable hints to headmasters or principals of the institutions briefly sketched in this paper.

A PLEA FOR THE MORE SCIENTIFIC AND SYSTEMATIC TEACHING OF BOOK-KEEPING.

By Stanley Latham.

Were an apology considered necessary in introducing the subject of this paper to the Congress I would refer my auditors to the pertinent remarks of Dr. Johnson who said, "Book-keeping is an art which no condition of life can render useless; which must contribute to the advancement of all who buy and sell, of all who wish to keep or improve their possessions, of all who desire to be wise. Let no man enter into business while he is ignorant of the method of regulating books. Never let him imagine that any degree of natural abilities will supply the deficiency or preserve multiplicity of affairs from inextricable confusion," And he might to-day have added. Those natural abilities, if finding their arena in commercial life, unless properly checked and regulated by a knowledge and application of the art of book-keeping, may not only bring that ruin in their train, which lesser mercantile abilities sometimes escape, but will possibly place their possessor in an uncomfortable and somewhat unsympathetic close relationship with the penal law.

The importance of a knowledge of the subject, however, is not confined to those only who are known as business men, for it is of equal importance to every member of the community who appreciates the variabilities and potentialities of the term "Income" and the often times unexpected and unexplainable vagaries of its correlative, "Expenditure." Since the days of Lucas di Borgo, hundreds of treatises have been written upon it, hundreds of persons have been engaged in its teaching; certificates of capabilities have been issued by public bodies and societies testifying that the holder has passed their examinations in book-keeping; and yet I undertake to say that probably 75 per cent. at least of the persons who have been taught, and are presumed to be book-keepers, are incapable of anything beyond the most mechanical and elementary work. The reason for this is not far to seek. From my own experience, both as a pupil and as a teacher, I am convinced, first, that most of the so-called text-books are inefficient, and, second, that those who profess to teach, either do not understand the science of systematic and sympathetic teaching, or that they lack that wide experience of this important subject, without which it is almost absolutely impossible to rightly teach the art of Book-keeping.

Consider for a moment what subjects are inseparable from the art:—Practical Arithmetic, Commercial Law, Banking, Political Economy, and last but not least, Ethics, as distinguished from the phrase "Commercial Morality." The field of instruction to be covered is not small, and yet no surprise seems to be aroused at the temerity of many who attempt it as instructors, whose position has been gained from the mere fact of their having acted as book-keepers themselves; their limited and imperfect practical experience being supplemented by probably an inefficient, but trouble-saving text-book.

Involving, as it would, some of the technicalities of book-keeping, it is as impossible as it would also be inappropriate for me here to give some glaring examples of the results of the teaching which have come before me during the past thirteen years. It will suffice to say that they resolve themselves into this:—That numbers of certificated pupils, after spending many months in obtaining their certificates, and then fondly believing that they deserve them, when asked to give reasons for their work, have been quite unable to do so, and when given a set of books differing in detail from those on which they received their diploma, displayed little more than that amount of knowledge to which total ignorance is almost to be preferred,

This state of things, I am afraid, is largely due to the fact that book-keeping is not recognised, or at least not sufficiently recognised, in our educational arrangements; and when it is placed in the curriculum it is often regarded as a superfluity and certainly as of no importance; the consequence being that the qualifications of the instructor do not match, in any way, those of his colleagues in their particular branches.

Let me sketch as briefly as possible the general lines on which, in most cases, it is thought that book-keeping should be taught; prefacing my remarks by saying that, on these lines, this system has always before it—that book-keeping is a practical subject and nothing more. A practical subject, the principles of which were probably deduced from an axiom of Euclid, or the properties of an algebraic equation!

The class possibly consists of twenty or thirty pupils, with ages varying between, say, seventeen and twenty-five, and each individual is duly equipped with a pen and ink, and one or more exercise-books. The students are then instructed to allot certain pages, or may be a whole book, to such titles as "Cash Book," "Bought Day Book," "Sold Day Book," "Waste Book," and "Ledger." The next step is a veritable plunge *in medias res;* they are told to write Debit and Credit (abbreviated to "Dr." and "Cr.") respectively on the left and right of the cash-book and ledger, and following this they are further told to write detailed items to the left or to the right of the former book—it being probably explained that these items are supposed to be received or paid—certain other entries are then directed to be made in the books other than the ledger, and eventually, under different titular headings, this last book is brought into play as the final recipient of the entries made in the other books, the pupil being instructed as to the mechanical positions which the entries must take. By this time he may or may not have also been introduced to what are known as bill-books and possibly to others which he is informed are of a subsidiary nature, such addenda being dependent to a great extent on the taste of the teacher, the age of his text-book, or the trend of previous examination papers. Within ten or twelve lessons he proceeds by this form of instruction to complete his experience by compiling a "Trial Balance," followed by a "Profit and Loss Account," and "Balance Sheet," and he is then the complete book-keeper.

Such is very broadly the method of instruction pursued in the large majority of cases in teaching book-keeping, a method founded on the old but sometimes mistaken aphorism that a minimum of practice is worth the maximum of theory. The required result is however achieved; the student by mere mechanical practice in a quantity of detail and by the examiner's knowledge of past examination papers is enabled to scrape through an examination and so to obtain his certificate of capability in an art of which, in reality, he knows next to nothing.

From this the question naturally arises, What then is a proper system of which book-keeping should be taught? I would like to premise the few observations I have to make in answer by saying, that unpoetical as the subject is, one might almost class the proficient book-keeper as one among those not made but born; for although, by careful attention and training, most men of ordinary abilities may become passable keepers of books, it is but a small per-centage of those who would learn that will ever become proficient book-keepers. I have already mentioned with what other subjects that of book-keeping is necessarily affiliated, and regarded from my point of view, I must insist that in teaching book-keeping on a complete and proper system it is absolutely essential to include these subjects in the curriculum if proficiency is to be obtained; and I suppose that that is the object in view as regards our students. In short I contend—a contention based on my own experience—that book-keeping must be taught on a more scientific, as distinguished from the existing practical method. In advocating this departure from the accepted mode of teaching it is of course incumbent upon me to suggest some definite course which should, in my opinion, be pursued. First then, the preliminary step will be to see that the pupil is grounded in a knowledge of practical arithmetic—for without this as a nucleus it will be impossible to proceed—assuming this knowledge which in the ordinary course of education will have been obtained before the student of book-keeping left his or her school, I suggest that the next stage should take the form of a short course of lectures, illustrated if possible on the blackboard—on the place and importance of book-keeping in commercial life and for statistical purposes. These lectures would necessarily include the practice of arithmetic and the other subjects to which I have already referred, which might be called "affiliated subjects;" definitions, commercial signs, abbreviations, and expressions would naturally follow, and this purely thoretical course would be completed by giving and explaining the axioms and formulas of the art. A very full printed synopsis of each lecture should be provided and presented to every student.

After the final lecture of this course it is desirable that a test should be taken of the amount of information that has been aquired and retained by the students, such examination having for its object the justification or otherwise of proceeding to amplify theory by bringing it into operation in practice.

Now although this first stage is to be allocated altogether to theoretical work it must not be imagined that that division will thereby be exhausted; on the contrary it will crop up at every important step when the student commences his practical work. It is impracticable to cut the two, so as to form two absolutely distinct divisions, but I am convinced that the student will have his way cleared for him, will understand better and take an infinitely greater interest in his future work if he has as a preliminary passed satisfactorily through the first course. We now have to take the practical and the theoretical in combination, and the end of this second course should leave the student in a condition to understand everything he has done and is doing, as well as capable of undertaking the proficient keeping of any set of books and of understanding any system of accounts with which he may be brought in contact. With these objects to be attained he must begin, if one can be allowed the expression, from the beginning, from the most rudimentary forms from which he has to obtain information to build up his various books, and which will eventually culminate in a complete and correct analysis of his own or of his employer's financial position. He must be taken through all the rudiments of book-keeping and accounts common to a certain model business, and proceed step by step so as to embrace in his experience almost every condition and important variation under which the books and accounts of that particular business can be kept, every opportunity being taken to explain the possible bearing on these transactions of what I have called the affiliated subjects. Questions must be invited, and the pupil must be encouraged to give opinions on and reasons for his work, the practical doing of which it is advisable should be more from his own judgment and discretion than from any direction given by the teacher.

Having taken him through one model set of books he should then be given another set of a totally dis-similar character as regards the business of which they are the records, but to which he could apply some of the experience previously obtained.

He must not, however, stop here, for although the principles of double-entry book-keeping are universal, the application of those principles varies considerably, and the book-keeper should, if thoroughly trained, in that training at least, have some experience from model sets of books of the diverse requirements of professions, merchants, brokers, insurance and other companies, charitable and similar intitutions, the Civil Service, local authorities, bankers and others. It will therefore be necessary to see that he has some acquaintance, at least, with the more patent standard variations which exist in the systems of accounting adopted by, and found necessary to different individuals and bodies, and for my own part I would not have this done perfunctorily, as heretofore, but devote to its study considerably more time and attention so as to obtain a result which could be compared with the best training he now receives in other subjects. Finally, the training ought to include instruction as to the methods for employing the art of book-keeping as a preparation for actuarial and statistical work.

We, who almost every day have to experience the results of an insufficient, or possibly the complete lack of, knowledge of the subject - matter of my paper, can only complain; and it rests largely with societies holding examinations and issuing certificates to see that their examinations justify these diplomas, or at any rate make them of some value. The form of examination questions, if I may say so, is at present based on lines too English, too old-fashioned. Let questions be more suitable to this end of the century's requirements, and the more thorough and scientific system of teaching which I advocate must follow. My subject, I venture to think, is important enough for the very best and fullest instruction. As taught at present, it is one remove from valueless, but when taught properly and afterwards conducted upon sound principles, it is invaluable. "Book-keeping not only shows the general result of a commercial career, but admits of analysis by which the success or failure, the value or worthlessness of its competent parts, or each particular transaction, can be easily ascertained. In a word, on the one hand it promotes order, regularity, fair dealing, and honourable enterprise; on the other, it defeats the machinations of dishonesty, and preserves the integrity of man when dealing with his fellows."

FRIDAY MORNING, JUNE 18.

SECTION A.

The Right Hon. A. J. MUNDELLA, M.P., in the chair.

THE TEACHING OF DOMESTIC ECONOMY IN GIRLS' SECONDARY SCHOOLS.

BY MISS MITCHELL.

Just as the higher education in general of girls distinctly gained by its late introduction, and was able to advance untrammelled by the rigid traditions hampering boys' schools, so the technical branch of that education may be expected to gain by the earlier introduction of technical work for boys. The introduction of technical work into girls' elementary schools will also lead to more satisfactory arrangements when the secondary schools take such work into serious consideration.

The influence of the technical work of boys upon that of girls seems at present to be distinctly harmful. Because metal work and carpentry have been found to be of great educational value, even when taken once a week, developing muscular dexterity and habits of exactness, the work considered suitable for girls has been run on very similar lines, a short occasional class being considered sufficient, in spite of the great differences in the operations, and the great variety of the materials used. Because a young boy gains much by his weekly wood-work, it by no means follows that a girl gains as much by her weekly cookery.

The work in elementary schools has been much hampered by the early age at which the pupils leave, and in the case of the girls, the cookery suffers from the difficulty of disposing of the materials used.

In High and Middle Schools the work can scarcely be said to have been taken up seriously—the classes being restricted usually (1) to those willing to pay a small fee, or (2) to a small proportion of the girls, entry to the class being a privilege. The last consideration is the individual educational requirement of the girls. The subjects have been almost exclusively cooking and needlework, dressmaking classes being special and plain needlework alone taught throughout the school. Laundry and house management have been left severely alone.

Now let us first consider the qualities in which the pupils turned out by the girls' secondary schools seem to be wanting. If the schools were doing their work properly one would expect their scholars to come to a domestic economy school, ignorant of the subject-matter, but with a thorough acquaintance with the nature of the materials used, and the natural laws involved in the various processes, ready with methods of investigation at their command, with well-trained senses and mental and muscular control sufficient for them to develop a new set of habits or a new skill. But they come to us wanting in all these points. Where thay have taken inorganic chemistry, it has not been quantitative, and has dealt with materials quite apart from those used in ordinary domestic life. Their knowledge of elementary physics is nil, and systems of ventilation, construction and management of stoves, systems of drainage and water supply, are as difficult for them as any other student.

In practical work they stand no chance against the girl who has been compelled by circumstances to turn her attention to practical matters, such as the eldest girl of a large family, or a girl who has for any reason had to undertake home responsibilities. She is observant so far as her eyes and ears are concerned, but not with her other senses, and she is not "common-sensed," does not foresee results, does not translate theory into action. In theoretical work she does much better than in practical. Everyone must acknowledge that the great failure of High School work is due to the absence of the practical side, and the time-tables at present seem to forbid the introduction of any such. At present the school hours are four in the morning, with an occasional afternoon class of 1½ hours. The morning is usually given up to five lessons, and I think, as compared with schools where the length of each lesson is longer, that a considerable amount is got into these; the mistresses and classes work at a very high pressure.

Now, practical work of any sort, either of the scientific or technical type, must be expensive, with regard to materials used, and especially with regard to expenditure of time. A practical class of three-quarters of an hour is absurd, especially where any attempt at exactness is made. An hour and a half is the least length, and two hours is better. The number of pupils must be limited, though a large class can be managed if greater time is given to preparation of apparatus, the class losing in habits of independence.

At present, head mistresses scarcely seem to have realised that a science or technical mistress cannot undertake a practical class of any size at a minute's notice, that a large part of her work must be done outside the class. A master preparing a theoretical chemistry lesson, does not consider two hours preparation by himself and a laboratory assistant excessive. It requires a very good teacher, an expert class, and copious apparatus, to start a practical lesson without previous arrangement. How many head mistresses would be satisfied with a practice lesson of two hours, or two hours separate theoretical lessons illustrated with experiments, as an equivalent for the ordinary morning's work of four hours given to five lessons? In how many girls' schools is there a recognised laboratory assistant for keeping account of apparatus, washing up, and keeping a laboratory in order?

It must be borne in mind that women are naturally not apt to turn to practical work. They have taken to this branch of modern education more slowly than to any other, and have made less mark in branches of experimental science than in mathematics, art, and literature. How much of this is due to generations of bad education, and how much to natural incapacity, is yet to be discovered; but in any attempt to carry out practical education in girls' schools, mistresses, usually requiring no spur and showing most scrupulous thoroughness in their work, will have to be warned against avoiding and slurring over the practical work for the sake of the theoretical.

At the present time, girls' education is being very much starved for want of money, an endowment of £1,500 per annum being considered large for a girls' school, while £4,000 per annum is considered very small for a boys' school. An expenditure of £5 for laboratory equipment for a girls' school is a serious matter, and even the flasks and test-tubes necessary for the simplest work would scarcely be forthcoming in sufficient quantity in many schools. This difficulty can sometimes be overcome by converting the school into an organised science school or by qualifying it for County Council aid.

So much for the general difficulties. The next point to be considered seems to be the practical work which could be most suitably introduced into a High School, and then we ought to consider the resources of such schools which might be turned to account in teaching domestic economy or technical work proper.

Now, in the Battersea Polytechnic, we have two schools from which information on the first point may be gathered.

A.—A DOMESTIC ECONOMY SCHOOL.

In this school my attention has been drawn to three points:—

(1) That girls of about fourteen, who come to us for about twenty weeks' training in domestic economy, and have already been through two or three courses of cookery in a Board School, have scarcely any advantage over the girls who have had none. Of course it is very difficult to trace results where so many causes may interfere. The girls whom we separated out as having been previously trained were found to be somewhat older than those who had not, and so could not be judged by quite the same standard. But in spite of age and training advantages their work has not in the long run been better than that of the others.

(2) We have a class of young voluntary school children, who come twice a week for cookery demonstrations and practice, and however carefully they are watched they gain very little skill or control over their hands. They learn, it is true, that fat being rubbed into flour must be kept cool, and that water must be added to the fat and flour, but if confronted with specially soft fat, or with damp flour, they would not know what alterations to make in processes; or, if a pudding turns out badly, they would not be able to say why. They can be taught to imitate certain processes in a sort of monkey fashion, and carry out hard and fast rules, and follow recipes, but nothing else.

(3) Then we have students in training, some of whom have come fresh from secondary schools of good standing, some from homes where they have been absorbed in domestic matters for some years after leaving school, some from business, and some High School mistresses. One, who had been seven years apprenticed to a trade, was an interesting case. She was a thoughtful, careful, clear-headed student, but she had great difficulty with her practical work. The cause of her failure was clear to her. She found it extremely difficult to store up sense impressions, never could decide whether the dough she was kneading was of the right degree of elasticity, whether the pastry she was preparing was sufficiently moist, whether her pie was the right tint when baked. Her memory was not capable of retaining these impressions, nor her senses quick in detecting them. In laundry work, where materials and utensils are much simpler, she succeeded very well in the end. In several cases the fresh school-girls have not been so successful as less educated girls who had had home-training. They were wanting in self-reliance and initiative. Another successful student had never been a pupil in any sort of school, being the daughter of a country clergyman. She was amusingly wanting in the "give and take" characteristics of scholars of public schools, but her practical life caused her to be very successful as a domestic economy student.

(B).—AN ORGANISED SCIENCE SCHOOL.

There are about 30 or 40 girls in the Organised Science School who are educated with about 100 boys. They get about 9½ hours per week of practical work, namely, 2 hours practical chemistry, 2 hours practical physics, 3 hours geometrical drawing, 1 hour art, and 1½ hours practical cookery or needlework. The teacher of cookery has been much struck with the quickness, handiness, and general progress of these girls as compared with the domestic economy girls, who spend almost the whole week in practical work, of which 8½ hours out of 28½ hours are given to cookery. The girls of both the schools come from the same Board Schools and are of much the same social standing, and come from about the same standards.

What I wish to urge is that the early introduction into a child's life of domestic economy subjects is a great mistake. The utensils to be handled and materials to be used are too varied and complex, and the senses employed are too numerous and require to be well-trained. One might as well teach a child landscape painting or wax-flower making, the ultimate utility of the subject having no immediate bearing on the immediate educational value. Then again the acquisition of mechanical skill requires constant practice. The skilful cook or housewife must have constant practice as much as the pianist or singer; her muscles, senses and intellect must be continuously trained.

This points to the necessity of making the domestic economy work continuous, whenever it is taken, the weekly lesson being of very little value.

If the domestic economy proper is to come later what preparation for it can be made by the school, say till the pupil is about fourteen years of age?

Dr. Armstrong has drawn up an excellent syllabus of domestic science, which is, I believe, to be adopted in London Board Schools. I believe this syllabus is to be discussed later, and I need only say that its keynote is exact measurement, and the investigation of elementary chemical and physical laws or phenomena. But a cook who religiously employed a chemical balance for all her cookery, who never stewed nor boiled nor baked without a careful observation of the thermometer, who knew the nutrient value of food materials as far as any chemist knows it, which is not far, could still be a very bad cook and housekeeper.

Exactness, as the chemist knows it, is not necessary to good cookery, and a knowledge of the loss of water incurred by drying vegetables and flesh, though valuable, is not all-sufficing for the cook.

I should be extremely sorry to see any such course displace the botany and natural history of the secondary school. Any practice in classifying, in storing up and recollecting past impressions of natural objects is of great value. The botany should certainly involve a study of plant structure, and the natural history include the habits and structure of common insects, fishes, birds, and mammalia. It is not easy to over-estimate the educational and practical value of such knowledge to the student of domestic economy.

It would seem, therefore, judging from the work of our science schoolgirls and others, that about eight hours a week at least ought to be given up to practical work of some sort or another all through the school course, such work not to include any technical work proper until after the age of fourteen.

From 7 to 10 this work could include per head about—

Hours.	
1½	Physical measurements, or some work similar to Doctor Armstrong's course.
1½	Clay or wax modelling.
2	Art, including colour work of some sort.
1½	Needlework.
1½	Botany or natural history.

From 10 to 14, per week—

3	Chemical and physical work.
2	Art.
1½	Botany and natural history.
1½	Needlework.

This could best be managed by increasing the school hours from 4 per day to 5 per day. In the organised science schools and most boys' schools, the hours are 5½ per day, and these are not excessive if a good proportion of the work is practical.

When, finally, the practical work takes a more technical form, I would urge that for a time, at any rate—at least six months; better a year—it should be tolerably continuous. Supposing school hours to number five per day, two might be given to ordinary school subject work and three to technical work; 15 weekly.

One great difficulty in introducing such work into Girls' High Schools is that parents grudge the time, and the girls themselves regard the work with a certain amount of contempt. But the latter can be conquered, and has been in some schools where the girls show a marked interest in home affairs and the practical side of life.

Also, if the practical work throughout the school course be made to have a direct bearing on cookery and laundry problems, those subjects will not seem so peculiar to the charwoman, but appear as practical applications of many laws established experimentally during school life.

The bestowal of valuable scholarships such as Intermediate County Council, if made to depend on examinations in these subjects, will also hasten the serious study of them.

Even if the time-table and teaching staff of the High Schools could be altered there would still be difficulty in finding practice for the domestic economy class. What is to become of the food? What house is to be directed and kept in order? In every school there is a caretaker, and dinners are provided for scholars coming from a distance. In the Roan School at Greenwich, this work has been given over to a highly-qualified teacher of cookery, who directs the cookery of the dinners and the cookery classes, and I believe she works the two branches together. It seems to me if this plan were extended, a properly-qualified teacher could find enough work in taking charge of living rooms and offices, aud in ordering and cooking dinners, in washing house and table linen of the school, and body linen from pupils' homes, to occupy the time and properly train girls of a High School of about 150 girls.

But, probably, the best solution of the question would be to establish small boarding schools in connection with High Schools, so that girls could pass from one to the other for a short time for their special training.

TECHNICAL EDUCATION IN RURAL DISTRICTS.

By the Countess of Warwick.

When the Council of the International Technical Education Congress honoured me with an invitation to read a paper on this particular occasion, I was somewhat at a loss to know what special branch of technical work upon which to touch. As, however, so much of my interest is centred on rural subjects, I decided that my contribution to the Congress should be a short paper on Technical Work in Rural Districts, with special reference to the Technical Education of girls and women, as its careful development may help—not a little—to stay the de-population of our villages.

Starting with the assumption that the Elementary Education Act of 1870 has provided every child with the means of acquiring a knowledge of reading, writing, and arithmetic, the next question is what scheme of instruction is to follow in order to arouse within the child's mind that interest in things of every day and outside life which will better enable it to understand the technical training that is to follow later. First then and all important to the country child should come the study of Nature—Nature in her many moods and aspects, Nature which surrounds them on all sides, and yet remains to many an unopened book, because their perceptive faculties have never been awakened. An intelligent appreciation of natural phenomena and natural laws when applied to agriculture might go a long way to relieve the depression from which our rural districts are suffering so keenly.

If, therefore, the curriculum of rural schools were made more elastic, the inherent curiosity of childhood might be turned to better account, and the careful teaching of the rudiments of natural science would provide abundant grounds for legitimate questioning—not to speak of the extreme value of the *mental discipline* which is unconsciously brought into play. Take for example some such suggestive course of graduated instruction as the following.

Commence with object-lessons, giving simple explanations of the simplest natural occurrences, illustrated by constant reference to natural facts. Teach the children such truths as the position of the earth in the solar system, the changes of the seasons, the causes of day and night; and let them *notice for themselves* the different position of the sun at the same hour of the day at different periods of the year; the different aspects of the heavens at different seasons and at different hours of the night. The action of rain and frost and running water should be *shown*, and from it could be built up a sound elementary knowledge of how natural agencies mould the surface of the earth and produce all the varied features in the country around their homes. Instruction should be given as to the names, characters, and structures of the commoner animals, plants, birds and insects which throng the woods, hedgerows, heaths and meadows in the spring and summer; and above all, special stress should be laid upon the sacredness of all forms of life; wanton destruction of flower or insect should be severely condemned. As a learned man has written:—

> "Unless for a good reason, such as injuriousness to crops or injury to man, there is no excuse for killing things. A flower growing in its natural position is a source of delight. A flower plucked and thrown aside is wantonly destroyed. Nothing is more lamentable than to see heaps of primroses and hyacinths torn up and flung by the wayside. The primrose is disappearing from the country round the large towns and so are many more of our common flowers. Our rare plants, birds and insects are "collected" to the verge of extermination. It is during childhood that the respect for life can be best indoctrinated, and in teaching elementary science it is possible to insist upon this, and to point out that wilful destruction in any form is an immoral act."

Before leaving this part of my subject let me touch upon the *quality* of the work done, however simple, however small. If a child can be taught to take a delight and pride in his or her work, to try and excel in accuracy and care in the elementary stages, this will afterwards deepen into personal enthusiasm and interest, which will go very far to check the terrible apathy and carelessness that arise from work done more or less as a machine instead of by a personally responsible man or woman. Utilitarianism should be kept altogether in the background.

Through the different stages of elementary education the child passes, having assimilated more or less of the instruction offered, if more, technical (including secondary) education will find a soil already prepared on which to sow its seed, if less, the rudiments of knowledge have to be gone over again, with a corresponding loss of time.

The question now arises, which fundamental subjects should be carried to further stages in rural districts? Certainly one should be reading, and

Reading cultivated as a means of acquiring knowledge from the accumulated experience of former generations, when books like White's "Natural History of Selborne," Miall's "Round the Year," and others of that character, will help to further develop habits of observation.

Writing can be carried on to the cultivation of the expression of ideas (in other words composition and letter-writing), to describing phenomena, and to the orderly keeping of records which should be neatly and legibly written; boys and girls should further be encouraged to keep descriptive diaries.

Arithmetic also is of extreme importance, as it will assist in the accurate keeping of accounts. Elementary principles of measurement could be introduced with the study of geometry, and would be of the greatest value to farmers and those who have to do with measurement of land, timber, haystacks, &c.

Local history could be extended into geography and the history of the country.

The elements of the following sciences could also be taught with great advantage to the future farmer or practical agriculturalist:—

1. Chemistry and physics.
2. Geology (for nature of soils, &c.)
3. Botany and zoology.
4. The principles of mechanism for those who have to do with machinery.

Obviously instruction in these subjects is useless unless good and practical, not by blackboard and chalk but by experiment and observation.

The first three sciences would be useful alike to boys and girls, but the last must be for boys only, and if accompanied by workshop practice it would be of great service to them later in life. Boys naturally take to handicrafts, and should be taught the use of tools.

In towns much of this instruction is carried out in the evening continuation schools, but in the country there is no organisation to take this work in hand except the County Councils through their technical education grants, and they are prevented by the Law from expending any of their funds on the teaching of the elementary subjects of reading, writing, and arithmetic. Continuation schools in rural districts are therefore not providing the instruction needed and it is not to be wondered at that they are in many places showing a considerable falling off. This is very much to be regretted as these could undoubtedly be made to provide exactly the kind of secondary education most needed in rural districts, they in fact provide in many cases the only secondary education available.

Continuation schools provide what we may call secondary education for children who have to leave the elementary school, say, at the age of 13 and to begin work at once. But there is a fair percentage of children whose parents are able and willing to make a sacrifice and to keep them at school for another two or three years, provided suitable means of instruction exist. This leads up to the question of secondary schools. In the towns ample provision in most cases exists for this education, and it is to be hoped that the day is not far distant when such schools will be considerably increased, if indeed there is not one established fairly within reach of all.

Many girls will have to leave the country and take up their residence in towns, and it is most important that they should be well equipped to take their place in the battle of life that lies before them, and the curriculum of their secondary education should include advanced instruction in the three R's, elementary science, French, German, shorthand, type-writing, and book-keeping. This is all the more necessary when we consider the many paths that provide occupations that women may follow in these days.

In the more rural districts, where the percentage of girls who would avail themselves of this class of instruction is necessarily small, the difficulties of the case would, no doubt, best be met by a liberal system of scholarships to be granted by the County Councils. The scholarships should be carefully graded on some such lines as the following:—

1. Scholarships covering fees and travelling expenses at some secondary or higher school for girls, say, between the ages of 13 and 16.
2. Scholarships for girls unable to leave home, entitling the holder to fees and travelling expenses to evening science, art, and technical classes in the nearest towns.
3. Scholarships of higher value to schools of art, science, women's colleges, &c., preparing the candidates for diplomas for teaching, &c.

The subjects of primary and secondary education have been dealt with so far. The former should be so arranged that it will prepare and lead up to the latter. We shall no doubt, some day have a rational system of education, and not a disjointed one, as at present, when due regard will be paid to the co-ordination of subjects of instruction. At present the great want is co-operation in all branches, but this is not likely to be while every branch of education is under a separate and distinct authority, often antagonistic to each other and encroaching on one another's grounds. In the same town we may see the voluntary schools, board schools, middle schools, grammar schools and technical classes all being carried on under separate authorities who have no regard for each other's work and consequently overlapping each other's efforts in many directions leading to waste of time, money, and energy.

We come now to deal with technical education for women and girls in rural districts. Let us consider for whom this instruction has to be provided. It will be for the wives and daughters of farmers, artisans, and agricultural labourers. Technical instruction is defined to be instruction in the principles of science and art underlying the industries. Now to the class with whom we have to deal perhaps the only industry especially applicable is that of dairying, which is more or less women's work. Beyond this the industry in which most will be engaged is the management of the house, and the proper bringing up of their families. The instruction therefore suitable to the larger class of the women portion of the population in rural districts is that including the domestic subjects cookery, laundry work, nursing, dressmaking and needlework.

I know it is objected by some that instruction in these subjects cannot be considered technical instruction, and that in some counties a strong feeling exists that while girls and women have a claim to a share of the technical instruction grants it should be given through science and art classes, secondary and evening continuation schools. It is also pointed out that the funds are placed in the hands of County Councils for the benefit of particular industries and not for any particular section of the population. But I consider that it is of the highest importance to the nation that these women should have the means of learning all that is necessary to become good wives and mothers, and that anything which tends to improve the conditions of the classes in question, either physically, intellectually or morally, is of the greatest service to the country.

The difficulty of providing this instruction is no doubt very great owing to a variety of causes, the apathy of the people, their shyness, and the difficulty of reaching them. The instruction must therefore be taken to them. Obviously the work must be expensive and therefore can only be undertaken by such bodies as the County Councils, and by them through their grants for technical education. It is satisfactory to note that all the counties are providing this instruction in domestic subjects. That their efforts are appreciated, is shown by the attendance at the classes.

In the women's subjects, as mentioned above, the numbers for the counties of Essex and Warwick are :—

Essex.

Total attendance at all classes in the county	20,704
Attendance in domestic subjects	6,062

Warwick.

Total attendance	10,526
Women's subjects	1,617

Cookery.—No branch of women's work is more important, but it must be taught on right lines ; we shall have achieved a great work when we have taught the wives of the working class the preparation of the many nice and wholesome dishes that lie even within reach of their limited incomes. To do this the following principles should be followed :—

1. To teach the value of economy and cleanliness.

2. To teach principles rather than to give recipes.

3. To teach the nutritive value of different foods.

4. To show that with the exercise of thought diet can be varied at no extra cost.

It is also important that in arranging for the teaching of this subject due regard be had to the means of the people, to their general lack of utensils, and to the unsuitability of any but the simplest cookery.

Nursing.—While it is of the greatest importance to the country that our women and girls should thoroughly understand the proper preparation of food, as bearing on the health of the country, it is also important that they should be taught the proper nursing and care of the sick, and the hygienic principles which should govern the management of their homes. We rightly take the utmost precautions against insanitation, but a good deal of our efforts are neutralised by the ignorance of our housewives of the simplest hygienic laws. The possession of a sound mind generally accompanies a healthy body. To obtain the latter for their children should be the study of the mothers. Our women should be so taught that when sickness comes they would know what to do at the right time, and would so understand the art of nursing as to be able to relieve the sufferer of as much pain as possible. A good nurse is half the battle in a case of sickness, and instances without number could be given where valuable lives have been saved by the care and attention of the nurse. The ideal nurse is one who will faithfully carry out the doctor's orders, and whose knowledge and skill enables her to obey those orders intelligently, and on an emergency to act with promptitude till he arrives.

The organisation of this instruction should be:—

1. Lectures to be given to the women by trained nurses.
2. There should be a county nursing association.
3. Provision should be made for the proper training of these nurses.
4. There should be a certain standard of training for the nurses, and this standard must not be too low.

Having discussed the value of technical training and the selection of various subjects, the next important point is—How is it possible to get the people in rural districts to avail themselves of this education? Neither boys and girls, nor men and women, are likely to learn very much, even if they have sufficient energy to walk some distance to the classes, after a hard day's work in the fields, but surely it would be possible to spare an hour or two every day, or even three days a week, for systematic study. When work is slack much time is wasted in idle gossip; would it not be better to turn this to account in learning to become better farmers and better cottagers? District technical schools should be opened within given areas, or a technical side to existing schools be developed; or, perhaps, better still, the schools of the whole district should be affiliated, with a technical school attached, for the use of the pupils from all. The grouping of districts must be determined by local conditions, and the practical scheme of education must be placed in the hands of a committee, who should leave the carrying out of their work to a competent and carefully-selected head-master. The money received by County Councils for the technical education grant might be well spent in equipping such schools. If a plot of land could be attached to the technical schools, it would be very useful for the purpose of experiment and demonstration in the field. Economy of teaching might be secured by having the same teachers for several schools serving each in turn according to a pre-arranged schedule of attendance. Further details, however, it is unnecessary to discuss in this paper, which aims at suggestions rather than conclusions. I would only emphasize that it is extremely important in planning out both schools and curricula, that everything should be directed towards cultivating plasticity of mind and a power of meeting new conditions and changes in the incidence of competing forces.

The Right Hon. Sir Richard Paget said that the paper teemed with excellent suggestions, so that the difficulty of approaching the subject was increased by the fact that it had been so comprehensively dealt with, and one was at a loss to suggest anything which did not already find a place in Lady Warwick's discourse, in which she seemed to have most completely grappled with the whole subject. What the difficulties of the subject were they knew very well. To put them as briefly as might be they consisted of the difficulty of knowing what to teach, and then how to teach it. One naturally leapt to the conclusion that if those were all, how easy must be the task, but they knew that for the teachers themselves the difficulties were immense in dealing with children who came from different homes. He thought they might congratulate themselves that the nation at large was on the right track. What they had to do was to teach the children to be useful citizens. Their object was to catch them young and train them, and that was being done. The State, as a State, had done that for us. It had determined that education should be compulsory for all, and so one of the difficulties which had existed in past years had been solved. They had caught the children young, but then the question came of what they were to teach them. In the rural districts, no doubt, the dairy-maid would always be in request, but if she were a skilled one, and knew the art of dealing with milk so as to make the best butter and cheese, there would never be any difficulty in her finding a situation in which she could make the most of her abilities. But they could not all be dairy-maids. Domestic service, no doubt, would claim a good number of them, and then there was the profession of nursing, to which much importance had very rightly been attached by Lady Warwick. One of the great difficulties was that at present our organisations were not complete. His own opinion was that the development of evening continuation schools afforded the best and simplest way of taking a further step. The county of Somerset was doing a good deal in that direction, for it was spending something like £3,000 out of the total grant of £13,000 to develop the evening continuation schools, and they looked to great good coming from that source. They were easily attended, and the schools could be multiplied to any extent. The work which Lady Warwick invited them to attempt was a work that must commend itself to everybody. It was not too much to say that the future of the nation was in the hands of that generation for which we were asked to do something, and in the various departments of life which lay before the children with whom we had to deal, he was very glad that Lady Warwick did not leave out the duty of the wife and mother, for that was the sphere, after all, to which nature called women, and anything which they could do which would tend to brighten the homes, and increase the happiness and comfort of that class in which they were interested, would be a good work, which, however feebly or imperfectly it were done, would, at least, give them some satisfaction to contemplate.

Mr. JOHN THOMAS hoped that the paper which had just been read to them would be printed and sent to all members of the County Councils. He was a member of the Technical Education Committee of the Bucks. County Council, and their great difficulty was that many of the members of the Council wanted to spend its money in repairing the roads, and they did not seem to think it was a good investment to spend it on education. Until the County Councils were more thoroughly imbued with an appreciation of the importance of technical education, he did not think much advance would be made. And for that reason he would like to see the excellent paper of Lady Warwick printed and sent to all the members of County Councils who had the responsibility of spending money on technical education.

Mr. Alderman T. SNAPE (Liverpool) said that, though the county from which he came was largely and properly regarded as an industrial rather than an agricultural one, yet one third of its area was agricultural, and that part of its area was equal to the whole of the area of the agricultural county of Cheshire. This was his justification for saying a few words upon the remarkably interesting paper to which they had just listened. He wished first to commend the important suggestion which the paper contained as to the necessity of greater elasticity in the curriculum of our primary schools, and the importance of teaching the causes of natural phenomena. The apathy of the child was thus removed and its interest aroused in the objects by which it was daily surrounded. He thought the most valuable part of the paper was that which suggested that the technical instruction should begin in the primary schools. He hoped very much that the Government would take to heart the suggestions made further on in the paper with reference to secondary education, and especially with reference to the provision to be made for the secondary education of girls by means of scholarships. Under the present law, scholarships were limited to schools where technical instruction was given, but in the Bill to be submitted to Parliament before the Session closed he understood that the law would be enlarged so as to enable them to employ their funds in assisting scholars to continue their education in secondary schools of all kinds. Upon the question of nursing, to which Lady Warwick had referred, some of those who attended the important Conference at Stafford-house upon that subject feared that a legal barrier existed against their funds being used for the purpose of training nurses, and for the employment of nurses after training to teach it in the homes of the people. Since then they had given their attention in Lancashire to the subject and they had found that a scheme could be devised by consent of the Department by which their funds could be employed for the training of nurses. Possibly when they arranged their next year's scholarships some provision in that direction might be made. He wished to add his testimony to the extreme value of the paper, and he hoped, with the gentleman who had last spoken, that it would find its way into the hands of the members of the County Councils of the country.

Mr. R. WADDINGTON, (Vice-President of the National Union of Teachers) wished to also add his testimony to the excellence of the paper which had just been read to them. It was admirably ideal, and if for a moment he desired to bring them back to the real state of the case, he hoped that they would not think he was attempting to disparage its excellence. At the present moment there were over 2,000 schools in their country districts, with an average attendance of less than 40 scholars, controlled by one teacher, and that teacher very often a woman, and there, he ventured to suggest, they did not want elasticity so much as money. Those schools had a Government subsidy of less than a £50 note, with a local authority—where there was a local authority managing the school — bent on saving the School Board rate, and existing only to evade the law. Unless they could imagine a scheme which could make these schools successful, short of a very much increased subsidy, he had very little hope of Lady Warwick attaining the admirable aims which she had in view. What was the condition of affairs which they had to face? Last year there were just over a million children between 11 and 12 years of age in the primary schools of this country. This year three-fourths of them had disappeared from school life on passing the 4th and 5th Standards. To-day one-half of the children of this country were free on reaching the age of 11 years, and passing the 4th Standard. If they anticipated the realisation of any such grand scheme as that which had been planned out in the paper just read to them, on such a foundation as the 4th Standard, with the probability of a lapse of two or three years, during which a boy or girl would forget the little he or she had learned, they were living in a fool's paradise. Until they had done something—as Mr. Mundella had told them the other day—to carry out the pledge which was made so long ago, and had been almost forgotten; until they did something to take from these small School Boards, which were so closely interested in evading the law, the power to enforce the law; until they were prepared to recognise what every Lancashire millowner would recognise in his business, that a huge school of 500 scholars could not be maintained at the same rate per head as a school of 30 or 40 scholars, they could not hope to bring about any amelioration of the state of affairs in the rural districts. One could not go through the country districts, as he often did, meeting the teachers who were working in the schools, and sacrificing their lives in the interests of the children under their charge, without feeling that rural England had made small progress in its industrial occupation. They went from farm to farm, and saw the same implements as those with which our rude forefathers tilled the land, and they had to remember that this state of things was very largely due to the Act of 1870, which gave local option in the enforcement of compulsory attendance to those who were most concerned in evading that Act.

Right Hon. HORACE PLUNKETT, M.P., who was called upon by the Chairman as one who was largely responsible for the interesting Report of the Irish Recess Committee, said that having only just come into the room, and not having heard Lady Warwick's paper, he could not keep strictly to the subject in hand, but he would like to say a few words upon a matter somewhat associated with it—namely, the new policy that they were trying to promote in Ireland. That country, the lives of whose inhabitants were pastoral and agricultural in character, might be regarded as a rural district. There was a growing number in Ireland who thought that the economic question in Ireland (and the Irish question was largely economic) was simply how to improve the conditions of rural life, and to increase the volume of agricultural production. And, as their Chairman had told them, a body of Irishmen, composed of all political parties, set themselves the task of discovering how countries, similarly situated to Ireland, had raised themselves from a condition of agricultural depression to one of agricultural and even industrial prosperity. After investigating the subject in nine European countries by personal visits on the part of their Commissioners, they came to the conclusion that the case of Ireland was not at all hopeless, and they issued a report which briefly expressed the conviction that first of all they had to get the people themselves to take an interest in the improvement of their condition, and, secondly (and perhaps this was the most frequent omission in schemes of social and industrial advancement) they had to organise the people. Schemes of social and industrial advancement could not be, in the first instance, promoted by the Government. The people themselves had to be organised, and schemes even of technical education, in their view, ought to be locally initiated, locally controlled, and only supervised, and, of course, to some extent, assisted and directed by the Government. They persuaded the Government to introduce the policy of State-aid to agriculture and industry. They did not ask them in any way to supplant the organisation of the people themselves, and, in fact, they only asked them to supplement their efforts in what they considered to be a perfectly legitimate and yet effective manner. He was sorry to say that, to everybody's surprise, this policy was dropped by the Government in favour of a reform of county government, which was, no doubt, a very admirable thing in itself. They hoped that the other policy would be taken up again, but in the meantime they attached more importance to what they could do for themselves than to what the Government could do for them. They were going to try—and so far as they could without the assistance of the State—to initiate local effort such as he saw, from a cursory glance, was prescribed in Lady Warwick's paper, and they believed that in a short time they would have the ground very well prepared for a scheme of Government assistance, such as was provided in countries like Denmark and Wurtemberg.

Mr. H. MACAN wished to bear testimony to the work of rural education in which the Countess of Warwick had been engaged. He wished Sir Richard Paget had told them at greater length of what was being done in the county of Somersetshire, which had taken the lead in continuation schools. There they had increased by leaps and bounds, and the work has been thoroughly successful, although it was a county which, owing to its prevailing agricultural character, suffered very much from the particular part of the law mentioned by Lady Warwick. But he ventured to suggest that the particular clause in the Act of Parliament did not, in a large number of our rural districts, operate adversely in the promotion of evening continuation schools. Having been concerned himself in the establishment of 70 such schools—three-quarters of which were in rural districts—he had found that taking away all the elementary education which ought to have been given in the elementary schools assisted in the development of those schools, and he had found that introducing into them the hereustic system advocated by Dr. Armstrong had the strongest effect in increasing the attendance of the boys. If any of the foreign visitors were interested in the matter they could see, not a hundred miles from London, 350 plots, attached to continuation schools, under cultivation by the pupils, under the guidance of an inspector, who travelled from one to the other, and in the winter months they could see the boys undergoing agricultural and horticultural instruction, and the general study of nature, which Lady Warwick had so well advocated. The education of the girls was very much more difficult than that of the boys in the evening continuation schools, and he could bear out what Lady Warwick had said as to the very great difficulty they had had in getting hold of the girls. The difficulties were not so much educational, as those arising from matters of home-life, and partly from social reasons, and he thought that some new development of policy on the part of the Education Department, in encouraging something like the day continuation schools, would be necessary before they could succeed in getting hold of the girls to the same extent as the boys.

Dr. RYAN (University College, Bristol) said his only reason for intervening in the debate was that he took great interest in agricultural work. The Countess had drawn attention to an urgent need, and had advocated it very ably. Technical education was too often associated with a repulsive and uninviting room, called a laboratory. It was a pity that those who spent the early part of their lives in the laboratory of nature should lose its advantages for the lack of organised help. It was strange, and at the same time, sad, to find young men who had spent 15 years in the country, coming to college totally ignorant of the very simplest principles of physiography or physical geography. There was no reason why a country boy should be less observant than a town boy. In particular he advocated the teaching of mechanics in view of the extensive applications of machinery in agriculture.

The Rev. R. C. FLETCHER (Lancashire County Council) said that his experience of technical education in rural districts, which had been not inconsiderable, led him to the conclusion that one thing which they had suffered from very much, and which had left its mark behind—a mark that it would take a long time to wipe out—was the innefficiency of the teachers who, at the beginning, undertook to carry out the work. It was found at the commencement that every elementary schoolmaster, after about 24 hours' notice, thought himself qualified to teach agriculture to farmers and others who had devoted a lifetime to the practical study of the subject, and though their inability was soon found out, it left a bad name behind, and technical education was in rural districts looked upon as a sham. And then, too, there was some difficulty amongst those who had to be taught. In his district a chorus of indignation arose as soon as cookery was mentioned, and there was a cry that it was insulting to suggest they did not know their own domestic duties. But these prejudices had been gradually overcome, and he had found that that teaching had been most successful which involved demonstrations of fact by means of things to be seen and handled. One subject which they had found to be very popular was that of ambulance work and sick nursing, and the difficulty at first anticipated, of teaching the subject before a mixed audience, was got over by dividing each lesson into three parts, and giving first half-an-hour to male students, then an hour to a general class of both sexes, and finally half-an-hour to female students; thus avoiding the treatment of delicate subjects before a mixed audience. No knowledge was more urgently required now in the rural districts than that of elementary care and precaution in the sick room, and when one saw the unnecessary pain to which a sick person was subjected through general ignorance on the part of their friends the necessity of further instruction became painfully evident. The rural people wanted to be taught a little more of the decencies of life, to be taught lessons of refinement and thoughtfulness, and not a little of that practical gentleness which was so essential to the comfort of the sick. As to the lack of elasticity in our elementary education, the Education Department was entirely responsible. The Code was provided, and the teacher absolutely tied down to it.

Mr. MAURICE JACOBS (Bucks) wished to say a word of thanks to the Countess of Warwick, not only because of the intrinsic merit of her paper, but also because he believed, or, at least, hoped, that it would be the means of drawing a little more attention in the Press to the needs of the rural districts. In his own district—Mid-Bucks—they had few continuation schools, but the Technical Education Board devoted a great part of its income, with a fair measure of success, to domesticating the women so that they might be able to make the most of their husbands' slender earnings. Health missioners had been much appreciated, and he hoped to induce his Board to extend the system to other subjects and send out cooking and needlework missioners to the houses of such of the working-classes as would welcome them. The funds at their disposal were very inadequate for the needs of a great county, and he hoped that their work might be inspected from time to time and receive from Government a large grant.

Mr. HENRY ACKERLEY (Wigan), although quite admitting the marked ability of the paper, could not agree with it on general principles. Mr. Snape had indicated the difficulty of interesting people in technical instruction matters in the counties. Why?

Because it was undoubtedly thought that the instruction given was not of a practical character. What was the money to be used for which at present they were spending on technical education? Generally speaking, he understood it to be that we might be enabled in our trade and commerce, to contend successfully with the competition of our rivals abroad, and the reason why there had been such little interest taken in technical instruction in agricultural districts was that it led to no practical results. The money given by the Government was for the purpose of making better craftsmen, and making a man proud to get his living with his coat off, rather than with his coat on.

Mrs. PILLOW (Ladies' Technical Committee, Norwich) said that when they got one central authority to act as an Education Department—right through from the infant school to the university—they would have a graduated system of instruction which would include elementary, secondary, technical, literary, and the higher branches of education altogether. One word as to teaching in rural districts. They had not aimed at securing that which the last speaker had lamented had been omitted from Lady Warwick's paper—How to reduce the price of produce. On the contrary, they had, by teaching butter-making, enabled the farmers to increase the price of their produce, and to sell their butter at a penny or twopence more a pound. That, at least, was a practical result of the education given.

Mr. R. P. WARD (Cheshire County Council) said the Countess of Warwick had laid special stress upon the training of young women in domestic housework. He would like to draw the attention of the meeting to what was done in his county to give practical effect to the suggestions made. A number of scholarships were granted for training in domestic work at the Institute, Worleston. The students were over 16 years of age, and during the morning some were instructed in butter-making, whilst others were taken into the kitchen, under the supervision of the matron, and the work to be done there was divided amongst them; and in the afternoon a trained and experienced teacher gave instruction in laundry work, cookery, the cutting out of garments, sewing, &c. A trained nurse attended once a week to give two hours' instruction in the nursing of the sick. Great interest was taken in the work, and the scholarships awarded were eagerly sought after. At the end of ten weeks an experienced married lady undertook a thorough examination of the students in all the branches of work. The whole scheme had been remarkably successful.

The CHAIRMAN said he appreciated fully the remarkable breadth and liberality of Lady Warwick's paper. It was a charming paper, and one that would repay careful and sympathetic perusal, and he only wished that all the ladies of her rank and station would take the same liberal and enlightened views of education that she had shown. The paper was so full of suggestions that it was almost impossible to comment upon it. It involved in the first place an educational reform of the very highest importance—that is, that there shall be in each district one authority, one public authority, to which shall be entrusted the whole educational work of the district. Now, before saying a word in detail, he must call attention to the statement that has been made by Mr. Waddington, of Bolton. He spoke of the short time that the children attend school, and of the impossibility of crowding into their infant minds all the knowledge that the British public required them to possess. Well, he fully agreed with him. Our whole educational system up to now had been, to use a homely expression, trying to put a quart into a pint pot. It is impossible if children are to be taken from school at eleven years of age—and many of them leave school earlier than eleven years of age—that they can derive any advantage from their education, or can turn it to practical account in their future life. He knew that in some of the rural districts there are some admirable schools. He knew a district, purely agricultural, where Lady Warwick's ideals are almost realised. The school is entirely managed by a lady who devoted her life to it, and the teaching of that school is of a most admirable character. He discovered it when he was Vice-President of the Council, and he had followed it up since. There is no better school in England, but it is all due to the wisdom, the intelligence, the application, and the sacrifice of one lady. The result was that the children did not come out of that school when they reached the age of 13 or 14, and the parents were beginning to see the advantage of keeplng them there, and the boys know the use of the pencil, and they go to the garden and green-houses and make drawings of the improvements they want to make, prepare designs for the laying out of garden plots, are carpenters and builders, and they have a general mechanical knowledge. The girls are taught excellent practical cookery. It is simply a revolution that has been worked there by having a really excellent practical school, with practical teaching. Our urban districts are improving in education greatly, but there is much to be done in the rural districts. During the present year he had visited friends in the country, and a schoolmaster said to him one Sunday afternoon, "I assure you that the whole object of the school attendance committee in my district is to turn every school into an infant school." What can the poor schoolmaster hope to do under those discouraging circumstances? And what a national disgrace it is that such a state of affairs should be allowed to continue! No child should be employed without a certificate that he or she has passed a certain standard and gone through a certain curriculum, and then we should feed the continuation schools, which would carry all the boys and girls up to 17 and 18 years, and it should be obligatory upon them that they should attend so many times a year until their education is practically completed. What a revelation, for instance, Denmark offers to our agriculturalists! What a puzzler it is to them! A country with worse soil than ours, with most severe winters, where they have the greatest difficulties of nature to contend with, and where they have absolute free trade in agriculture—and yet these people, through intelligent teaching, and co-operation, and that organisation to which Mr. Plunkett has referred —these people are sending us ten millions worth a year of agricultural and dairy produce, flooding the country with it, and it fetches the highest price that can be obtained throughout the length and breadth of the land. It is a fact that we are receiving every week of our lives, every day of the year, £10,000 worth of Danish butter. What an extraordinary fact it is that whilst our climate is so well adapted for dairy produce that we should be bringing these enormous quantities from foreign countries when we ought, and are able, to supply them to ourselves! Let us try what we can do to make our own children as intelligent, as thrifty, as productive as the people of other countries, who are such reproachful examples to us.

Lady WARWICK said she was glad to hear the remarks from Mrs. Pillow, because the women of the eastern counties feel deeply what an important question this is. Referring to the school mentioned by Mr. Mundella, Lady Warwick said she hoped to emulate that lady by the little school of her own—a continuation day school for boys and girls—in the remotest part of Essex, where it was utterly impossible for the County Council evening classes to be of any good at all. It was an experiment which started in February with two scholars. They are increasing every day, and next year she hoped to have 200 at least. The County Council had approved her efforts, but cannot help her, because these day continuation schools do not find favour with them. But the whole question is what is to be done with children who, at the age of 13 years, at the most critical time of their lives, are thrown out upon the world forgetting all they have learned in the elementary schools.

TECHNICAL EDUCATION IN SECONDARY SCHOOLS.

By Miss Fanny L. Calder,
Hon. Sec. Liverpool Technical College for Women.

Amongst the educational developments which form such a distinguishing feature of this last quarter of the 19th century, none, perhaps is more remarkable than the acceptance by the recent Royal Commission on Secondary Education of "Domestic Science" as a branch of secondary education. Certainly nothing shows more completely how public opinion in England can be revolutionised, when persistently "instructed" as to the needs of the generation. No doubt English educationalists have been woefully backward in recognising the necessity of educating "the maker of the home" in the duties of her calling, but when at last the need was seen and acknowledged, the organisation of well conceived plans and methods progressed rapidly, and the present position of home-lore in England is behind that of no other country in efficiency and completeness. Two main hindrances had to be overcome in accomplishing this end. First, the idea engrained in men's minds that all women understand by nature the duties of home-life, that because a mother *ought* to know how to manage her home, therefore she *does* know, and consequently that to attempt to teach such every day details is a pure work of supererogation, and a waste of time and money. The second hindrance was based on narrow prejudice, and, therefore, more difficult to deal with. It was loudly and scornfully contended that to introduce into the educational system of the country the practical teaching of subjects relating to woman's special work, the management of the home, was a degradation of education itself, was placing girls in an inferior position to boys, and wasting the precious hours of school life, which ought to be devoted entirely to book-learning.

It was not until philanthropists and other leaders of public welfare awoke to the fact that a vast economic loss was entailed upon the nation through the ignorance of its women of the most elementary principles of thrift and management, that the force of these objections was gradually withdrawn and opposition changed into hearty and substantial co-operation.

It was Dr. Samuel Smiles who pointed out that "from want of culinary skill English people waste as much food as would feed another nation," and, yet, in the great educational scheme of 1870 no one dreamt of trying to rectify this evil.

It was the Royal Commission on Elementary Education of 1887 which laid down the principle "that the true object of education is to give such instruction to the scholars as will best fit them to fulfil the ordinary duties of the life to which they are most likely to be called," and "to encourage such training in school in matters affecting their daily life as may help to improve and raise the character of their homes."

But the main factor in bringing about that complete change of front which is so striking in the educational programme of the last ten years, was the steady, persistent effort on the part of educationalists connected with various schools of cookery to prove to the public the possibility of domestic subjects of every kind being taught in classes, on true educational lines, and with all the methods and accuracy of science.

Personal acquaintance with the general life of the people had plainly demonstrated to the committees of such schools that ignorance of all that goes to make up the comfort of a home was at the root of much that debased and impoverished the nation, and that nothing would help so much to raise the tone of domestic life as to educate *all* women and girls in the useful detail of daily duties, and not merely those for whom such work was to become a profession. Practical education was a great national want.

Beginning, therefore, with cookery as the first necessity of a household, systematic courses of lessons were thoroughly elaborated, combining principles with practice, and suitable in details to the varied requirements of the different classes that would take advantage of them. One by one the sister subjects of laundry-work, household sewing, home dressmaking, and domestic millinery, were worked out on the same lines, accompanied in each case by the syllabuses, recipes, and manuals necessary to render the instruction educationally complete.

The result of these efforts fully justified the term of "domestic science" as applied to such practical subjects when organised as education, and prepared the way for their subsequent adoption as a suitable form of "technical education" for women. Of course the training of teachers in all these branches went hand in hand with their progressive development, and the establishment of technical colleges for women was a consequent duty entailed upon the initiators of this movement.

Between the years 1876-1890 such of the domestic sciences as had then been formulated and recognised by Government were only taught in elementary and in evening continuation schools, and the path of progress was blocked by the fact that the time-tables of these schools were already overweighted and nothing more could by any possibility be crowded into them. After 1890, the time when public zeal was thoroughly aroused as to the necessity of organising special technical education for men and boys, came the longed-for opportunity of finding the suitable position in national education for the special subjects required for women and girls. As "secondary education," and upon the completion of the years of elementary school life, time could be more completely and satisfactorily given up to the study and practice of domestic science, and an often-felt gap between the time of leaving the ordinary school and the entrance upon the duties of girls' respective callings be filled up. Thanks to the public spirit of those who formed the first County Councils and had to deal with grants of money set apart for the purpose of promoting technical education, this opportunity was pretty generally recognised and agreed to when appealed for by those who led the way in all these organisations. Classes were established all over the country, for women and girls, in the specially womanly subjects of cookery, laundry work, household sewing, home dressmaking, and hygiene. Let it be thoroughly understood that these classes were by no means *professional*, but were arranged entirely with the view of improving the home life of the people. The value of these classes went far beyond the immediate result upon individual learners, they acted as educators of public opinion, and as object-lessons to all concerned in the welfare of the nation and the promotion of education, by showing the necessary lines upon which girls' education needed to be conducted, if our women were to be found equal to those of other countries in the knowledge and practice of home-lore.

Through such definitely organised instruction it was seen how education was ennobled, *not degraded*, by its application to the art of "spending" as well as to that of "earning." "Domestic *science*" no longer needed the apologists, who for years had to fight even for the terms in which the "new learning" might be expressed, but as "secondary education" became a needed and recognised branch in the Code of public education, and is now rapidly developing upon two distinct lines, either as a domestic science side of the usual secondary school, or, as a "secondary school of domestic science" only. By adopting these two methods of working, technical education is brought within the reach of all the different sections of the community. To girls who are able to prolong their education and remain up to 17 or 18 years of age in secondary or intermediate school, these technical branches can be taught gradually, and mostly during the later years of school attendance. For example several intermediate schools opened in Wales under the recent Intermediate Education Act, have introduced technical subjects side by side with the usual literary branches, and domestic science takes its place in the daily time-table, as any other science might do. And this method is being increasingly adopted in all directions. On the other hand, for girls, whose education cannot be very prolonged by reason of their calls to work either at home or in some remunerative employment, a more concentrated system is necessary, and "schools for secondary education in domestic science" only, have been established. Here the whole series of domestic subjects is included in the course of about six months' duration, and the curriculum comprises only, or mainly, the practical subjects named before as the necessary equipment of a housewife, viz., cookery, laundry work, household sewing, home dressmaking, domestic millinery, and hygiene; *with the addition* of general "housewifery," and in the most complete schools this last is taught by practice in a house in *permanent occupation as a residence*, so that the instruction may be thoroughly applicable at home, and not be learnt by theory, or on diminutive specimens of house gear. These schools are open to any girl, and are attended day by day from 9.30 to 4.30, like any other day-school.

On these lines the Liverpool Technical College for Women is working the scheme of "Secondary Education in Domestic Science."

The several subjects work simultaneously and are taken by different classes in turn for a week at a time, so that no one branch becomes monotonous or detrimental to health. By the end of a course every girl has had several weeks in each branch, each return showing the increased intelligence developed by the variation of the work.

The literature of these sciences is also a valuable and most useful accompaniment. Accurate and simple penny manuals for scholars have been published as each branch was developed, and have doubled the benefits to be derived from the instruction given in the classes by thus providing really suitable and inexpensive books for home reference.

Technical and other committees are now offering scholarships, to be held at these domestic science centres, which include free education, meals on school-days, and the materials required for making up the various articles in the sewing, dressmaking, and millinery classes.

Some of these scholarships are given for a second course only, as in Liverpool by the Liverpool Council of Education, in order to prolong the instruction from six to twelve months, the length of time to which "a counsel of perfection" would extend every course.

In some counties hostels are provided, and board and lodging are given with the scholarship, but this is chiefly in smaller towns where the scholars are drawn from distant villages or remote hamlets and in consequence could not manage a daily attendance. Such a school is working at Worthing in West Sussex.

The position Technical Education has now attained is this: first, the establishment of technical education in domestic science for girls in secondary schools of one kind or another all about the country, open to all, so that any girl may have the opportunity of learning at a very small cost all the practical sciences which comprise the everyday duties of the housewife; and, further, that the educational value of methods by which head and hands work together, without the sacrifice of one to the other, is fully recognised and accepted whenever and wherever new educational schemes for girls are under consideration, and is duly taken into account.

NOTE.—In the Victorian Era Exhibition at Earl's Court, in the Education Section of the Women's Department, the Liverpool Technical College for Women has an exhibit of "The Development of Domestic Science Education in England, 1837-1897." The exhibit is 15 ft. along the wall, and shows the subject under three headings, "Elementary, Technical, and Secondary." Photographs of students at work in all the branches, syllabuses, manuals, and sketches depict the system pursued by the Liverpool Technical College for Women.

HISTORY OF TRAINING SCHOOLS FOR TEACHERS OF DOMESTIC ECONOMY IN ENGLAND.

By Miss Pycroft.

Organiser of Domestic Economy Classes, Technical Education Board, London County Council.

In a gallery of the Bethnal-green Museum, in the East of London, out of the way of most visitors, and known to a very small proportion of the inhabitants, there is a collection of food stuffs, made as long ago as 1857, since added to from time to time and re-arranged. To this collection, apparently so unimportant, is to be traced the origin of the great movement in favour of the teaching of cookery, and consequently of other branches of domestic economy, that has gone on for the past 25 years and is still spreading throughout this country. The idea of making a collection of food stuffs had occurred first to Mr. Twining, of Twickenham, who made such a collection for a private museum. But the food stuffs at Bethnal-green were collected for the Science and Art Department by Lord Playfair, Dr. Lankester, and Mr. Buckmaster, and were at first housed in the museum at South Kensington. Thus the Science and Art Department may claim the credit of having sown the seed of the great movement which followed, though its development was due to other agencies.

It was proposed by some members of the Commission of the International Exhibition in 1873 to show there samples of food and food-stuffs, with the view presumably of interesting the public in little known articles of food and encouraging their importation, and it occurred to Mr. (later Sir Henry) Cole, who was a member of that Commission and also of the Science and Art Department (but who in this case acted in his capacity of commissioner only) that, while a collection of food and food materials would excite little interest and would be for the most part unnoticed by the crowds of visitors at the Exhibition, lectures on food accompanied by practical demonstrations of cookery would, from their novelty, attract a large amount of public attention. It was difficult to determine how the mixed lectures and demonstrations should be worked, but it was decided to ask Mr. Buckmaster, who had already studied the composition of food-stuffs and helped to collect them for the Science and Art Department, to deliver the lectures, and he has described to me how he was sent for and asked at three weeks' notice to undertake the work, and he has told me also his dislike of the task and his despair of obtaining all the necessary information in the small time at his disposal. The books in existence did not give him the facts he wanted, for the science was new, the composition of food-stuffs and their work in the body was even more imperfectly understood than it is now, and the chemistry of cookery presented still more unsolved mysteries; and, moreover, he knew nothing of practical cookery. However, the work had to be attempted. The practical part was arranged under the management of a French chef, with four women doing the actual work under his guidance, all four performing the same operations simultaneously at different parts of a counter stretched across a wide hall, while Mr. Buckmaster lectured from a sort of rostrum near at hand; lectured twice a day from May to November, working up his lectures between whiles, seeing new facts, discovering new reasons for them, feeling more and more at home in his subject as the time went on. And the event proved that Sir Henry Cole was right, the lectures attracted a constant stream of visitors, chiefly of the uppper and upper middle-classes, and great public interest was excited in the subject.

From that time Mr. Buckmaster was contantly appealed to from all parts of the country to give lectures on food with cooks demonstrating under his directions. The idea took firm hold; philanthropic women, realising the immense advantage which a knowledge of cookery would be to their poorer neighbours, started cookery lectures for the poor as well as for the rich. The very first cookery lessons had indeed been given in Wakefield Vicarage in November, 1872, where a professional cook was engaged to give instruction in high class cookery in the mornings, and, in the evenings, lessons in economical cookery to a certain number of school girls, ladies being present at all these meetings to see that everything was made clear to the pupils, and to look after the general management. But after the exhibition of 1873, cookery lessons were arranged in several of the northern towns, and in London a number of influential people whose attention and interest had been aroused by the exhibition lectures, formed themselves into a committee with the Duke of Westminster at their head, to consider how the desired object of establishing a centre for cookery teaching on a permanent basis could be attained. The result was the foundation at South Kensington in 1874 of the National Training School of Cookery. Here under the management at first of Lady Barker, and in premises lent by the Science and Art Department, cookery lessons were given to numbers of wealthy people. For a time it was the fashionable thing to take a course of cookery lessons, and the object for which the school was founded lay more or less in abeyance,—that namely of supplying instruction to the poorer classes, who, it was felt, suffered much in health and comfort for want of a knowledge of the elementary rules of cookery and of the value of different kinds of food. The courses of lessons given in the first year seem odd enough now. They consisted solely of practice lessons in scullery work and in peeling and cooking potatoes in the mornings, and of demonstration lessons in cookery in the afternoons. Pupils entered for ten days' courses of this kind of instruction. The teaching was of course given by cooks; no trained teachers of cookery existed as yet, but it soon became evident that teachers of a higher type than the professional cook were needed if the principles of cookery were to be fitly taught, and that to engage a scientific man to lecture while the cooking was done by others was an expensive mode of obtaining instruction and not in every way the best. A demand for a different kind of teacher and different methods of teaching arose, and in the next year when Mrs. Clarke, the present lady superintendent of the school, began her work, two new developments took place, one the opening of a practice kitchen for what is technically termed artisan cookery, and soon after, the opening of a training school for teachers of cookery, teachers who should be instructed in the theory and should be prepared also to teach it practically. The course of training occupied but two months, only one paper was set by way of written examination, and diplomas were issued on the strength of that paper and of an examination in teaching cookery by demonstration. The written examination papers were, however, examined by a very competent authority, the late Dr. Hans Busk. It seems curious now, when the length of training is at least quadrupled, that anyone should have imagined such a training and such an examination to be sufficient—all the more curious when we consider that the movement had been started by scientific men, who, from the first, must have realised the amount of accurate knowledge required by those who were to attempt an explanation of the changes that take place during the various processes of cookery and the reasons for those processes. However, so it was, and in the first year ten students received their diplomas as teachers of cookery, several of these being women sent up for training from Liverpool, Edinburgh, Leeds, Birmingham, and other towns, where it was intended to establish cookery schools. The next year, 1876, thirty-nine teachers were trained; and in this year also a great step was taken in the foundation of other training schools for teachers of cookery. It was felt by committees working in towns in the North of England, that as the work grew, and they had faith that it would grow, a large number of teachers would be needed, and that the expense of sending many teachers from distant parts of England and even Scotland, to be trained in London would be greater than could be met, and they therefore called a conference which met in Liverpool in the same year, 1876, to discuss the question of forming a union to examine and grant diplomas to students in other training schools for teachers of cookery.

A proposal was made to the National Training School of Cookery that it should act as a university and send out examination papers and issue diplomas to provincial schools, but the committee answered that their constitution did not enable them to agree to the proposal. They felt, it seems, that it was unnecessary for the sake of the work to open any other training school than that at South Kensington, and that the whole work of training could be done in London.

The schools which were represented at the Conference were those of Liverpool, Glasgow, and Yorkshire (where schools had been established in the towns of York, Leeds and Wakefield), and these schools agreed to form themselves into a Union for the training of cookery teachers, and to grant diplomas on the result of training given on prescribed lines, and of examinations conducted, as regards written examinations, by one examiner for all schools, and as regards practical examinations, by the committees of the various schools on lines laid down by the Union. The title adopted was, by reason of the situation of the original schools, the "Northern Union of Schools of Cookery," and under this title, the band of schools worked for many years, having a very important and distinct influence on the teaching of cookery. Other schools joined the Union as time went on, the school at Leicester being formed in 1877 and taking its first teacher from the training school at Leeds, where at this time the term of training was three months, showing that the need for longer instruction for teachers was already making itself felt. Occasionally a school left the Union (as in the case of Leicester, which now runs independently as the North Midland School of Cookery) but the number in the Union increased, till some eight years ago, seeing that the old title no longer corresponded to the area covered by the schools in the Union, nor described the full extent of its work, this title was changed to that of "National Union for the Technical Education of Women in the Domestic Sciences." At the present time there are eleven training schools working under its auspices.

But from 1876 to 1889 is a long leap and the intervening time had brought many changes and a great advance in modes of training.

The Northern schools felt almost immediately their work began that if a knowledge of cookery and of food materials were to touch the poorer classes and influence their modes of living, instruction in the subject must be given to the children, and though this could be done on a small scale by voluntary agencies, it could only be done permanently and on a large scale if the subject were recognised by the Education Department as one for which grants could be earned; it had already in 1874 been recognised as one which might be taught in elementary schools. The ladies at the head of the movement in the Northern Union decided therefore in 1877 to present a memorial to the Education Department, begging for a grant on cookery lessons to school children, the desirability of the appointment of an inspectress of cookery was also discussed by the Union, and pressed for by its hon. sec. The Department finally acceded to the request, and a grant for the teaching of cookery was made in 1882. It was a matter of course that, as soon as the subject was admitted into elementary schools, the Education Department, since it did not itself propose to undertake the work of training teachers of cookery, should have the right of accepting or refusing to recognise the diplomas issued to the teachers by various training schools. The National Training School of Cookery and the schools of the Northern Union, which had drawn up and presented for approval syllabuses of lessons to school children, were at once recognised as schools approved by the Department, and a few others soon obtained recognition. For a time, in order to meet the demand for cookery teachers in country districts, a lower class of diplomas called local diplomas was granted after short courses of instruction or examination in cookery to teachers in elementary schools, and these were recognised by the Department, it being considered that the small knowledge of cookery professed by the holders of these local diplomas was counterbalanced by the skill in teaching which the trained teacher possessed, for the cookery schools, though they had improved their training slowly yet surely, had not yet given their students much training in the art of teaching. Classes of children attended at the training schools and served as practising classes for the students, who were also sent out to school and evening classes as opportunity occurred, but no definite provision for training in educational methods was made; however, the better schools worked steadily onward increasing the length of training and adding fresh subjects, increasing also the thoroughness of the examination, on which the granting of the diplomas depended. Lessons on school method were given in some schools, but the value of the training and the final test examination varied largely.

Meanwhile, owing again to the initiative of the schools of the Northern Union, it had been impressed by a deputation from these schools upon the Education Department that lessons in laundrywork would be only less valuable than those in cookery to the pupils in elementary schools. The honorary secretary of the Union, Miss F. L. Calder, had drawn up a syllabus showing how such a novel subject of instruction should be handled, and in 1890 a grant was made by the Department for lessons given in laundry-work to school children. There was, therefore, now a second branch of domestic economy, for which special teachers were required, and some of the training schools of cookery began at once to make arrangements for training students in laundry-work. The National Training School of Cookery did not for several years see its way to provide training in any subject but cookery. The Northern towns, therefore, led the way, and it was about this period that they changed their title, as previously stated. The Education Department had now an interest in, and influence on, two branches of practical instruction in domestic economy, and it soon took steps to regulate the time of training and to secure for the students adequate practice in teaching classes of children. In April, 1893, the circular, well known in all cookery schools as "Circular 317," was issued, requiring all schools which wished their diplomas to be recognised by the Department as qualifying their holders to teach in elementary schools to provide as a minimum period of training:—

20 hours a week for 6 months for a cookery certificate,
„ „ „ „ 3 „ „ „ laundrywork „

and to see that in the case of cookery teachers one month, and in the case of laundry teachers, three weeks, should be given to teaching classes of children under proper supervision. The circular also withdrew the sanction of the Education Department from the lower class diplomas called Local Diplomas, or Teachers' Licenses, the duration of which had previously (1891) been limited to a period of three years, after which time the holder must be re-examined, but elementary school-mistresses were still allowed to teach cookery to children in their own schools after a course of not less than two months' training. This circular did much good in raising and making more uniform the standard of training; it was thought at first that it would have the effect of killing off some of the smaller and less efficient schools, for increased training meant of course increased fees, and increased fees might mean a diminished number of candidates for training. But another force had been at work in stimulating the energies and widening the sphere of the training schools. The Customs and Excise Act of 1890 had put a large amount of money at the disposal of the County Councils all over the kingdom for the purpose of technical education; and the various branches of domestic economy and the training of teachers in these branches were recognised as some of the subjects which might be aided from these funds. Many classes in cookery were started. The demand for teachers was at first larger than could be supplied, and for a time very large salaries were paid for their services. The natural result was a rush of students to the training schools, but many of these not being persons really fitted for the profession, failed to give satisfaction to their employers, and partly from this reason, and partly from a natural desire to show themselves as capable of training teachers as their neighbours, of providing instruction "made on our own lines, gentlemen, and guaranteed the best," many towns and counties opened training schools, and these were, almost without exception, aided by public funds, and, therefore, escaped the difficulties which had beset almost all the other schools, in a struggle sometimes seeming almost desperate, to make receipts and expenditure balance. Some of these new training schools joined the National Union, others ran on an independent basis. The schools at Gloucester, Bath, and Bristol, are instances of the first, the schools at Cardiff, Norwich, Newcastle-upon-Tyne, and, in London, the Lambeth School (founded by means of a grant from the Berridge Trust, and not with County Council money, with the express object of training teachers for elementary schools connected with the Church of England), and the school at the Battersea Polytechnic, mainly supported by the County Council, are instances of the second. A tremendous impetus had been given to technical education by the Customs and Excise Act, many of the old schools as well as the new, now received help from their County or Borough Councils; and, more than this, better ideas of technical education were in the air, so that the training was improved on all sides. The minimum term of training prescribed by the Education Department, and which applied to teaching in plain cookery only, though in almost all cookery schools the higher branches were also taught, was soon exceeded, and new branches of domestic economy, comprising needlework, dressmaking, millinery, and housewifery were added, so that now almost all subjects which can be included under the term "domestic economy" are taught in the majority of training schools. Moreover the impossibility of teaching such a subject as chemistry from text-books or by lectures unaccompanied by practical work is being more and more realised. Some schools, unable to supply laboratories for the use of their students, now arrange chemical lessons for them outside their own walls. At Battersea, the only school of which I know that has this advantage, regular and special courses of lectures and practice lessons in chemistry are given to the students of cookery and laundry-work, and here also, for the first time, a permanent mistress of method has been appointed to train the students regularly in educational theory and practice. In all the 30 schools of cookery and laundry-work at present recognised by the Education Department there is still doubtless room for much improvement, but happily those who have to do with managing the schools, are bent on improving them still further. The one great want at present is uniformity of examination, and consequently of a standard in the diplomas issued. Various attempts have been made to attain this since the first attempt failed in 1876, but none have succeeded, diversity of opinion and the love of each school for its own ways have hitherto proved too great, but many are agreed now that the Education Department is the right authority to deal with the question, and are looking forward to the action which will, they hope, be taken by that body in the near future, with regard to the subjects of cookery and laundrywork, if not of all branches of domestic economy, and which, while leaving to each school freedom of initiative and experiment in many ways will yet maintain a just and equal standard of examination in all.

The history of the schools which I have given so imperfectly is one of 25 years, years in which huge growth has been made by education in many countries, but in whatever direction this growth has taken place, there is none, I think, which should be of more permanent benefit to the community than that of bringing scientific knowledge and accuracy and intelligent thought to bear on the ordinary and everyday work of our home lives. All honour to the originator of that little collection at Bethnal-green, the yet unexhausted seed of so great a family of plants.

TREATMENT OF DOMESTIC SCIENCE AS AN ELEMENT IN GIRLS' EDUCATION.

By Miss L. Edna Walter, B.Sc.

At a time when the domestic education of women is considered worthy of ranking as technical education it is wise to consider how its standard may be raised, and how it can best be instilled.

Domestic work will never be regarded as in any way comparable with professional work unless it rest upon some surer foundation than rule of thumb. If there is any work which is a direct and easy application of simple scientific facts, that work is the daily routine of an ordinary house. The simplest of chemical facts manifests itself at every fire, and the simplest of physical laws regulates the hot water upstairs. If only this were realised by everyone, and girls' education modified accordingly, we should have household work much more easy and pleasant to everyone, with possibilities of greater variety and less conventionality in arrangement, and probabilities of fewer burnt saucepans, badly laid fires, ill ventilated rooms, and undrinkable tea. In spite of a generally prevalent opinion to the contrary the universe has not arranged itself so that one set of chemical laws obtains in the laboratory, and another in the kitchen; there is only one chemistry, so that that must be *the* chemistry wanted in the household. For the sake of those who are afraid of the words "chemistry" and "physics" in connection with women's work, I hasten to add that the amount required is not very great, and ought to be learnt at school. The more these subjects are studied the higher will be the recognised position of domestic work. But however desirable it may be to raise the professional standard of domestic economy among women of ordinary culture, it is still more imperative that whatever part of it is taught to the girls in the elementary schools should be so taught that they may derive the greatest possible educational benefit therefrom.

A movement, led by Dr. Armstrong, has been on foot for some years to teach fundamental science in a sensible way. Adopted with greater readiness in some boys' schools, both secondary and elementary, it has obtained a footing which time will strengthen and success secure. More slowly is it finding its way into the privileged precincts of girls' schools, but a victory was won when, after several years of steady perserverance and patience on Mr. Heller's part, his scheme for a scientific course for girls was accepted by the London School Board and incorporated in the Code. The syllabus occurs under the title of "Domestic Science," and is taught actually in the schools by the class teachers acting under Mr. Heller's guidance. It is being suggested that the domestic science should be placed in the hands of the teachers of domestic art—*i.e.*, into the hands of the instructors of housewifery, cookery, and laundry work. Whether it is better that the class teachers should do the work, or that it should be in the hands of a specialist is obviously a matter open to discussion. I do not intend to go into that matter now, but wish to place before you my view on the subject of the mental equipment of these teachers of cookery, &c., if they are required to teach the science at all. I think it will be well if I briefly outline what I mean by domestic science and what by domestic art. Under domestic science I should include measurements of area, volume, weight, and density the latter exemplified in any hot-water circulation or system of ventilation; the study of the physical behaviour of substances when heated leads to the construction and use of thermometers and to the understanding of the value of materials for clothing. The chemical behaviour of substances on heating leads to the appreciation of certain stuffs as food, and to the proper understanding of the nature of combustion, with its enormous bearing on household economy. This is not the place to go into details, but the above will give an idea of what I mean. In the domestic arts are taught the cooking of many dishes, washing in all its details, even to the cleaning of coloured silks and Jaeger garments, and housewifery, including sick nursing, and the cost of a meal.

In order that this scheme may be successful, the same teacher should give instruction in the three subjects, and the teacher should be fundamentally a science teacher.

I must insist upon the fact, that unless these subjects have an educational value, they have no right to be taught in elementary schools. Utility *per se* is not a sufficient reason for teaching a subject, but it is, I am afraid, often considered sufficient for the introduction of cookery into the curriculum of the elementary schools. I would humbly suggest that for mere utility, there would be a gain if the boys could learn cooking; they would then, as men, be able to obtain a good meal, the lack of which is believed to drive them so often to drink, and their unfortunate wives would not then be held responsible for their husband's shortcomings. It would appear that cooking, just for itself alone, would have more far-reaching effects and higher moral results if taught to boys as well as to girls. I am not sure that the necessity for domestic subjects is not rather overrated in the case of girls. It seems to be assumed that they must all live by practicing domestic arts, and hence these arts must be drilled into them at all costs. Many, however, earn their living by working at various trades, wherein their wage-earning power is in no wise increased by proficiency in the domestic arts; but they are all sacrificed to the domestic fetish. They are taught a little cooking and washing during time which should have been used in cultivating what I may call "gumption." They are therefore less valuable to their employer, and when the opportunity for cooking and washing arrives they will have forgotten the little they learnt at school. If the improvement of their homes is the sole object of teaching them housewifery, laundry work, and cookery, then the training is unscientific and educationally far less useful than it might be. There is a tendency now-a-days to consider that these things are scientific in their bearing and to miscall them "domestic science." They are not domestic science at all, they are domestic arts. I do not for one moment want to deny that all these subjects are useful—in fact every woman, and I might say every man also, would be the better for knowing something about them—but when we consider the terribly short time at the disposal of the children, it is not sufficient that they should be taught *good* things; it is of the utmost importance that they should be taught the *best* things. But—and this is the point I want to emphasize—although the arts themselves are not efficient educational factors, the science underlying these arts can be taught with immense value to a girl if it be taught by the right people. It can be taught in such a way that it benefits every girl alike, whether she works in a factory or toils in a home. It becomes, therefore, of urgent importance that the right teachers should be obtainable.

The teachers have usually followed a course of training calculated to make them practical house-keepers able to teach their own subject as a craft. But can the art of housekeeping be taught to children of 11, 12, or 13 years of age? It is only when the subject can be made a vehicle for training that its utility should be recognised, otherwise it becomes merely a tax on memory. The cooking for instance is a mass of recipes which possibly frequent practice may cause to be moderately remembered for the time but not understood, the laundry work more recipes with less exactness, and the housewifery a practical joke. It might be thought that this state of things would be improved if scientific explanations were introduced at various stages, but explanations to the children, although a little better than nothing, are far from being sufficient. An explanation of a fact, given by a teacher, by no means necessarily causes understanding on the part of the child. Learning the explanation is of no use unless the child sees the reason in her mind, and other methods are much better for obtaining that result. This is the main difference between scientific training and other training. Explanations of observed facts should come from the child, and not from a teacher, and the child should be led to devise ways and means of supplying satisfactory reasons for herself.

A further step is now being taken which, at first sight, seems very satisfactoy, and is, indeed, a considerable advance, but the weak point of which I will endeavour to show. Into the various branches of the domestic economy course are being introduced experiments of physical or chemical nature, which have a bearing upon, or relate to, the particular domestic problem under discussion. This is like building a house without foundations, but pouring in a little concrete here and there on the ground floor after the house is finished. It may strengthen the house, but it is obviously not the best way to do it. So these experiments are helpful in the understanding of the domestic problem, but they should come first, and the domestic incident be used as an example. These merely illustrative experiments lose all continuity. It must also be seen that the same experiments may be repeated in different branches of the subject, for overlapping, with its consequent waste of time, must certainly occur.

As an example the laundry teacher would evaporate some water to shew the solids whose presence in solution made the water hard.

while the housewifery teacher would wish to do the same experiment when dealing with drinking water, or the cookery teacher when discussing boiling. The treatment of the science as the definite fundamental subject will obviate these difficulties and have results more far-reaching than the teaching of the mere crafts, results of infinite value to those who will pursue those crafts, and of equal value to those who will not.

I should here like to quote the statement of Dr. Kimmins, the science inspector of the Technical Education Board. He says in the Board's last report, referring to secondary schools:—

"In physics, previous to the introduction of physical laboratories, subjects were taken that could be dealt with in ordinary class-rooms, and the apparatus used for lecture illustrations was of the most meagre description. In inspecting schools in 1892 for the purpose of Llewellyn Smith's report, I was much impressed with the unsatisfactory nature of the teaching in this department. Young boys were introduced to difficult branches of the subject, and facts, the bearing of which was imperfectly understood, were committed to memory to meet the exigences of grant-earning examinations.

"The recent introduction of courses in experimental science, in which the work is almost entirely practical, and includes useful exercises in elementary mensuration, weighing, and elementary mechanics, has been attended with the best results. Boys take the best possible interest in this work, and when the exercises are arranged in a systematic manner it forms an invaluable introduction to other branches of physics. It will, moreover, prove of great service to boys who will enter workshops on leaving school.

"The more difficult branches of physics are now usually introduced at a later stage than formerly, and after a good preliminary training in weighings and measurements.

"In the teaching of chemistry, radical changes have also been introduced. Qualitative analysis, which has always been the bane of practical chemistry teaching, is now taking its proper position in the courses of instruction in this subject. In badly-equipped laboratories, where thirty or forty boys were taken by one master, it was the only kind of practical work possible. The necessary appliances consisted almost entirely of test-tubes and bottles of reagents, and, moreover, grants were awarded on the results of examinations in this subject. A scheme of work including the investigation of bodies, the preparation of gases, &c., and the general introduction of quantitative exercises, is only possible where the laboratory is well equipped, and, which is a matter of the greatest importance, where there is an adequate teaching staff, so that not more than twenty boys do practical work together under one master.

"In a few cases there is a tendency to cling to old methods of practical work, but the more rational kind of instruction is rapidly gaining ground, and the teaching in the lecture-room and laboratory is no longer divorced as in the days of qualitative analysis.

"The improvement with regard to science teaching in girls' schools is about as marked as that in boys' schools."

What Dr. Kimmins has said of the utility of such work to boys on entering workshops is equally applicable to girls on entering kitchens and laundries. Those of us who are doing our best to improve the science teaching in girls' schools owe a debt of gratitude to Dr. Kimmins for his sympathy and support.

Now, in secondary schools where girls remain until they are seventeen or more, it does not very much matter if they are taught cookery as an art or not. They have a good enough general education, and a sufficiently reasonable scientific education (which, as Dr. Kimmins points out, is gradually and surely improving) to enable them to grasp the nature of the problems and to attack them intelligently. But in the elementary schools the case is very different; the domestic science is to *train* them. Hence the teachers for this work should receive a different training from that received by those who work in higher spheres.

The polytechnic schools of domestic economy and cookery, provide a course of training for women, whom I may divide into three classes: 1, those who will use these subjects as a handicraft: 2, those who are to teach in similar institutions to women of the first class: 3, those who will teach in elementary schools. With regard to the first class it is interesting to learn from the report of the Technical Education Board that "there is a constant demand for the services of girls who wish to enter service" at the end of the course. The consideration of the second class comes more within the scope of Miss Pycroft's knowledge and work. I believe that there is no course specially adapted to the requirements of the third class in any polytechnic, and I should like to suggest a course. In the first place, the girls should have been at a good school until the age of about seventeen years, during which time they should have received an elementary education in science, a course such as that given in the syllabus of the Association of Head Masters or drawn up by Mr. Heller as "domestic science," or sketched by me in a paper which I had the honour of reading before the British Association last year. It is to be expected that after this a girl will have learnt how to think; she will not necessarily have much scientific knowledge, but will have acquired a certain amount of scientific habit. Now let her go to a college or to a polytechnic where the teaching is of approximately university rank. Let her study physics and chemistry in a thorough fashion; she will repeat her former work in a better laboratory with more delicate apparatus, and thus she will see the weak points in rougher methods and understand the sources of error. But she must of course go much farther into the subjects themselves than she has hitherto done, and should if possible undertake some simple piece of research. Concurrently with her science course she would be studying the arts of cooking, washing, and house-keeping, with some physiology and hygiene. I want it to be understood that in her case it is not sufficient to just play politely with physics and chemistry, she must do real quantitative work, and not be content with pretty experiments. It may be considered by many that only those points should be studied which immediately bear upon the domestic arts. I will give an illustration to shew how advanced the necessary science must be. Every cookery teacher is required to know something of the nature of foods; water and salt may be easily grasped, but organic chemistry is required when we come to alcohol and vinegar, while the mysteries of proteids and sugar are yet unravelled. Now, I do not mean that the girl, whose career we are considering, should teach her later pupils the constitution of the sugars, but I maintain that her knowledge should be considerably in advance of what she has to teach, and that she should not resemble that teacher of first stage physiology who pioneered his class successfully through the skeleton by keeping himself one bone ahead of his followers. Having gone through this course, which I fancy should be one of three years—but I do not wish to dogmatise on that point—our student may, if necessary, learn the art of teaching, and can then commence work. This sort of teacher will do an infinite amount of good in the elementary schools. I am accepting the facts as they stand when I say that this teacher is to know her domestic arts well. Both the London School Board and the Joint Committee on Manual Training require these arts to be taught. What I want is, that they shall be taught as accessories to scientific training and not that a smattering of scientific knoweldge shall be subservient to the arts. If the former course is followed, we shall gradually make all our poorer women more intelligent, and thus raise the intellectual standard of the race. If the latter course is to be adopted, we give them no chance of throwing intelligence into their work, but bind them down to rule of thumb for the whole of ther unnatural lives. It may be asked, how are teachers, such as I have suggested, to be obtained? Since they will be working with elementary school children, I must assume that they are of the same class as other elementary teachers. Now, scientific teaching needs a higher intelligence than literary or arts work, so something might be done to encourage the more intelligent girls desirous of becoming elementary teachers to take up this work. At the present time the encouragement is on the other side; the teacher of the ordinary subjects obtains I believe, a higher salary, has more opportunities for promotion, and also has always the hope of obtaining a head mistress-ship. There is, I think, often a feeling that teaching these practical subjects is a little less dignified than instructing others in the mysteries of parsing and practice. But the social feeling of disqualification will at once disappear if the subject be studied and taught in the way I have suggested. Make a course of nearly University rank compulsory, and the social status of the teacher is settled. The money question is far more serious but could easily be arranged by the action of the London School Board or Joint Committee. When once that is done, good teachers will be forthcoming. I know I shall be accused of having suggested an impractically elaborate scheme, and am quite prepared to own that I have counselled a perfection to which I fear it will be long before we shall attain. We can, however, start upon the right path for our future teachers and give all the help in our power to our present ones.

Although I have sketched an ideal course to be followed by teachers for the elementary schools, yet I know that at present no systematic course for such has been devised. Consequently I do not wish to complain of those teachers who are already engaged in this work, but would rather extend my cordial sympathy to those who are endeavouring, amidst the difficulties of their work, to study its scientific aspects, and who are devoting some of their little leisure to the repairing of lost time.

THE RELATION BETWEEN GENERAL AND TECHNICAL EDUCATION.

By Miss E. P. Hughes.

Member of the Technical Committee of the Cambridge Town Council.

In considering such a difficult and complicated problem as "The Relation between General and Technical Education" it will probably save time to begin by defining the two kinds of education. I propose to use the term "technical education" in a different sense from that in which it is interpreted by the law of England, in connection with the Technical Instruction Act. As my audience is doubtless aware, technical education is a delightfully elastic term, which most obligingly includes almost every subject except Greek and Latin and the teaching of a definite trade, with the sole exception of the trade of home-making. Educationalists give to this term—technical education—a different meaning, and it is in the educationalists' sense that I propose to use it to-day. I will venture to define it as any special preparation in knowledge and skill which is required for any skilled work. This obviously excludes unskilled work, and for practical reasons I propose to exclude also from the present discussion the technical training required for the professions. Professional work assumes a basis of *liberal* education, and therefore preparation for that work can be isolated and treated separately. As a matter of convenience I propose, therefore, to limit my inquiry to technical education as a preparation for skilled work other than professional.

General education I take to mean the development of the whole individual as an individual, and not with reference to any special work which he may be going to make his life-work. I wish to emphasise strongly the essential difference between preparing a mason for his trade, and giving an all-round general education to a boy who may become a mason, or a carpenter, or a lawyer. The end in view in these two cases differs so fundamentally that I think it is fairly safe to assume that the methods appropriate in the two cases are also likely to differ greatly. The real importance of the relation between general and technical education can only be appreciated by those who see clearly the fundamental differences between these two kinds of education.

The importance of technical education should scarcely need emphasising at this stage of civilisation, but there is one aspect of the question which is not often emphasised, which perhaps I may be pardoned for introducing, as it appeals especially to teachers connected with general education. After school days are over, one of the biggest factors in the education of an individual is the way in which he carries out his life-work. His happiness is largely affected by his attitude of mind towards the work by which he earns his livelihood, and to which he has every day to devote much time and thought and energy. If he is intelligently interested in it, if he knows its latest developments, and especially if he himself invents improvements, however small, his life-work must be a source of great pleasure to him, and also a source of considerable education, instead of tending to become more and more mechanical, and therefore tempting him to fly to excitement, very often unhealthy excitement, to counteract the monotony of his work. There is also scarcely any kind of work which would not be better done if the workman thoroughly enjoyed doing it, rather than did it only because spurred on by necessity. It is therefore of the greatest importance that technical education should be carried on satisfactorily, affecting as it does the intelligence and happiness of the workers as well the efficiency of the work.

In almost every institute for technical instruction which I have visited, the same complaint has been made: "We cannot do our work properly because our pupils are badly prepared when they come to us," which really means that these pupils have had an unsatisfactory general education. Technical education at present is undoubtedly hampered because the general education which precedes it is not carried on satisfactorily. Technical instructors grumble, and grumble considerably, at the teachers who give general education. My opinion is that a good general education ought to prove a satisfactory basis on which to build up a satisfactory technical education, and that the technical instructor has a right to expect certain powers, certain skill, and certain knowledge in boys and girls who come to him from a general school. We general educationalists must consent to have our work tested in this way, and we must not be satisfied with our course unless we send to the technical instructors boys and girls possessed of certain knowledge and skill. But we maintain strongly that this test by the technical instructor is not a complete test of our work; and it is possible for us to satisfy it, and yet not be giving a satisfactory general education. No man is *only* a skilled workman, and we have not only to prepare him for technical work, but also for his life in society, and as a member of a community. Again, he is an individual with the rights of an individual, and this life is not all. We have to arouse in him many and varied interests outside his life-work, his home, and even his nation. We must teach him to enjoy his leisure—that leisure which every man ought to have each day during his working years, and also that time of leisure which in the normal life ought to follow the years of hard work. We, in our general education scheme, have to lay the foundation for all these sides of life, and not only for the technical side. Still, the man of whom we are speaking is a skilled worker, and must earn his livelihood, and we acknowledge that his general education must include a foundation upon which to raise a satisfactory technical training, and I agree with the many who complain that we do not at present lay this foundation altogether satisfactorily.

Let us try and see what it is that the boy ought to know, and what he ought to be able to do before he passes to the technical instructor.

First. He ought to have been trained to observe carefully and accurately, to be capable of quantitative as well as qualitative observation, of intense and prolonged observation, and lastly, of that kind of observation which is required when experimenting is used.

Secondly. He ought to have been taught to make careful and effective records of observations. He should be able to draw and paint what he sees, and thus use "this shortest of all shorthands." He should be able to describe verbally, and to write clearly and vividly, an account of what he has seen.

Thirdly. The boy should have been taught to gain knowledge by reasoning, and he should have felt the delight of tracing cause and effect.

Fourthly. He should have been kept in a hungry state of mind. The natural inquisitiveness of the child, which is so often regarded as troublesome, which is so little encouraged in some of our schools and homes, which in itself is easily satisfied, may be developed into that intelligent and keen desire for knowledge which is characteristic of the well educated man and of the scholar. This inherent and childish inquisitiveness should, of course, be developed, and the boy should be taught to want to understand what he does not know, to be able to detect difficulties, and to be keen about solving problems. It has been truly said that some of the teaching methods of to-day, tend to crush out, rather than to intensify this hungry state of mind.

Fifthly. If an intelligent intellectual hunger has been developed, it follows, as a matter of course, that this state of mind becomes a strong motive for intense and prolonged work. Also, in developing that intellectual hunger it follows as a matter of course, that the boy should have been taught to work by himself, to think for himself, to know how to use books and teachers and lectures, and also to enjoy his work keenly. "Please don't help me, I can do it myself," I heard a little child plead with her teacher, the other day. The power of grappling with a difficulty by oneself is an immense help in all technical training.

Sixthly. No general education is complete unless the historical side is represented. We are placed in this world for a short space of time only, and we were never meant to live only in the present. Education enables us to stretch out our time-horizon into the past and into the future. One of the most important lessons which the historical aspect emphasises is the idea of progress and of evolution. It is of the greatest importance to teach a modern boy not to be satisfied with what exists at present, not to wish that things should remain as they are now, but to be on the look-out for improvements. Whatever work we may be employed in, it is of paramount importance in these days of rapid progress that the worker should realise the necessity of invention and improvement, and become more and more accustomed to the idea that these would naturally be discovered chiefly by those actually engaged in the work.

Seventhly. I think the technical instructor has a right to ask us to send to him pupils fully developed physically, not with bent backs, contracted chests, and short-sighted eyes, but strong and vigorous boys and girls, with well-developed and agile bodies. The extraordinary concentration of population into big towns, which has been so marked a feature of English life of to-day, makes it inevitable that a very large number of English children should spend their childhood in towns. It is impossible to make the conditions in towns as wholesome for children as in the country, but education can help to neutralise some of the drawbacks. For example, an excellent system of drill, encouragement of games, and developing an appreciation of beauty in art will do much to make up to the child for the loss of the health and beauty which is only to be obtained in the country.

Eighthly. The technical instructor has a right to demand a certain amount of general manual dexterity, not the special dexterity required by any special trade, but the general manual dexterity which is the basis of all skilled manual work. It has been urged that the man who cannot use his hands is not a completely educated man, and this is true I think.

Ninthly. In these days of increasing co-operation it is very important that our workmen should learn to work with other people, should know how to obey, to organise, and to command. Games and school societies give excellent opportunities for developing this power of co-operation.

It may be asked—Would you teach a boy science before he goes to the technical institute? My answer would be that if the boy can observe and record well and can reason, if he is skilled in manipulation, if he has learned to work by himself, and can work with others, the technical instructor could soon teach him all the scientific knowledge required to form the basis of his particular trade. Probably, however, the easiest and most desirable way of developing these powers would be to give him, by the best possible methods, among other things, some elementary knowledge of the two most fundamental sciences—physics and chemistry.

It may be asked, would yon teach him modern languages? We all know how hampered English lads are at present because of their ignorance of foreign languages. My answer would be this: I should certainly make the general education of every boy include one foreign language, because it has been rightly said that no man knows any language until he knows two. If he has been taught one foreign language in the right way, that is to say, if his ear has been largely cultivated, if his power of speech has been developed, and if the grammar has been intelligently taught, he will gain easily such other foreign languages as may be required for his work.

I think that if a boy goes to the technical instructor possessed of the nine qualifications which I have suggested, the technical instructor would have no reason to grumble, and we should have done a part of our work in providing a satisfactory foundation for technical training. I would, however, rigorously exclude from our general schools all strictly technical subjects. The time and place of teaching them is elsewhere. If a good foundation is laid the technical instructor can teach his part more rapidly, and more intelligently, if it follows a good general education, than if general education and technical instruction went on side by side, at the same time and in the same place. If they are separated we shall also be less inclined to sacrifice the one for the other, and more inclined to use in each case that kind of method which is most appropriate.

I turn for one moment to the general education of girls. At the present time in our elementary schools their general education usually includes two technical subjects, sewing and cooking, and in some cases laundry-work and hygiene. I would, without any compunction, exclude all technical work from our girls' schools. As this view is at present a great heresy I will attempt to give some reason for it. I consider that the most important trade in England, that in which we employ the largest number of people, which is the worst paid, and in which the work is at present the least well done, moreover perhaps the only trade which can never migrate from our shores—and therefore it is the more important that we should improve it—is the trade of *home-making*. How little does modern science really improve the home of the working man? How little are real business methods to be found in the management of middle-class homes, and what a waste of time and energy there is in the management of a very large number of the homes of this country. The home-maker is only too often a half-educated woman, who has never made it her business to learn her business, and who usually knows nothing of the scientific basis of her work. To a large majority of girls home-making will be the most serious work of their lives, and to all a certain knowledge of house-management is of considerable value. I should suggest, therefore, that after a girl leaves school, she should, as a matter of course, take six months in a technical institute (in evening classes if otherwise impossible) and study the following subjects connected with the management of a home:—

1. Sewing, not the ridiculously fine needlework which I sometimes see in some schools, so detrimental to the eyes and back and lungs, and so useless for practical purposes, but the kind of sewing that a girl of that particular class would need, and for economical reasons I should include a little knowledge of millinery.
2. Cooking.
3. Nursing.
4. The principles of the management of a healthy home.
5. The general principles of the training of young children.

If a woman marries, and this will obviously be the case with all except a small minority, or if, as daughter or sister, it falls to her to manage a home, it is clear that she should undergo a longer and more detailed course. If she receives some information about the reforms in home-making, which are being discussed today (and many reforms are necessary !), if she is told something of the customs and habits of other countries and other times, we should not find so much of that foolish conservatism, which assumes that because a thing was done in a certain way in the past, it follows essentially that it shall continue to be done in the same way. In this day of constant change and progress, and of great development in applied science, it is of the greatest importance that our home-makers should be on the alert to develop and improve.

I therefore suggest not less but more technical training for women, but would urge that it should *follow* their general education, and be at a different time and place. It is obvious that a cooking class in an elementary school must interfere with the regular work of the school, and that sewing takes up a vast amount of time, time which is wanted at that stage for other things. It is sometimes urged that unless a child begins to sew early, it will never sew well. The fact that men are (alas !) our best dressmakers, and that most of them begin their apprenticeship beyond the elementary school age, proves I think that this is not a fact. The educational value of sewing is, I believe very small, for one knows that girls who have spent many hours in sewing, are remarkably clumsy in a laboratory. The manual dexterity acquired in sewing would naturally be small, because the movements required are so few, and there are so few tools used. The accuracy of cooking is also not sufficient to make it of any great educational value.

While I would thus give our girls a short course on home-making, say six months, I would venture to suggest that the boys should not be forgotten. When they have left school, they might be taught a small amount of carpentry, and the simple mending which is required in all homes. This would prove very useful, and a boy who was going to the Colonies could take a longer and more complete course. Some training in first aid in cases of accident would also be of considerable use to boys.

We have heard frequently lately that Germans are absorbing a good deal of our trade because of our lack of technical intruction in England. I once asked an intelligent German who had been giving me some startling facts about certain parts of British trade which had got into German hands, how it was that after all British trade was still fairly large, and how it was that we had held our own so well in the past ? His answer was that we had succeeded in the past largely by a combination of luck and British pluck, and that this was not a snfficient basis for permanent success. I hope in the future we may possess also highly trained technical skill and knowledge, as well as British pluck and enterprise, and I have no fear then but that the British citizen will hold his own and do excellently in the skilled work of the world.

Let me once more return to the chief points of my paper.

First. No technical instruction can be satisfactory unless it is based on a good general education.

Secondly. While the technical instructor has a right to expect a certain knowledge and power and skill in his pupils, this end alone is not sufficient for general education, which must do more than lay the basis of technical instruction.

Thirdly. It is of great practical importance that we separate the time and place of general education and technical instruction.

Fourthly. The nine qualifications for technical instruction which I suggested, supply, I think, the reasonable demands which technical instructors may make of those who control general education.

Fifthly. The trade of home-making, because of its great importance, deserves special training and special help. It is not for the sake of the woman that keeps the home, but for the sake of all those who use it, that I would plead that a considerable amount of money should be devoted to teaching English girls how to manage a home economically and at the smallest cost of time and effort. This will never be done until it is realised that to manage a home really well requires considerable intelligence, much knowledge, and considerable skill. It is in fact highly skilled work, and can only be done by a highly skilled workman.

Let me conclude by urging that it is much to be regretted that the term "technical" is used in more than one sense. The most desirable meaning appears to be that which is accepted in this paper.

Mr. J. H. Reynolds said he thought Miss Hughes was entirely right in insisting as strongly as possible upon the absolute necessity of restricting our elementary and secondary schools to general education. Only in that way was it possible to prepare pupils properly for the technical schools of this country. In other countries the educational system was based upon the idea of compulsory and general education dealing only with those subjects which would train the faculties of the pupils, and fit them for their future life, as men or women—based upon the idea that the instruction given them shall be continued long enough to make it a permanent possession, and thus enable them to take advantage of the technical and special education which was afterwards given in the schools arranged for the purpose. They were urged yesterday to observe the necessity of sending our children well prepared into these special technical schools, and he thought they ought to bear in mind that the British representatives at Congresses such as that must look very seriously to the fact that our position as successful competitors for the world's trade and commerce was at stake. If that were so, then the nations with whom we were in most serious competition were the nations we ought to study, and when we did study those nations—whether German or Swiss—we found that their success was due not to the introduction into the general schools of a variety of subjects of a special character, but to the establishment by them of a sound system of general education, continued compulsorily until the pupils reached 14 years of age. If parents insisted that their children were to be wage-earners in the household, and at the same time that they should be taught these so-called practical things as aids to a living, they were asking for two absolutely incompatible things, and were undermining the future of the boys and girls of this country by turning them out of the schools imperfectly trained and educated.

Dr. GLADSTONE, F.R.S., wished to say a few words about a subject which had been before his mind a great deal—and the success of the London School Board, in introducing this kind of education, gave warrant for the hopeful prospects we now had, Practical education was being introduced in all directions, and he especially wished to confirm what had been said about the importance of domestic science, which appeared for the first time in the Government Code. It appeared in the Code of the day schools. and in a much more practical and complete manner in the Code for the evening continuation schools. At present, of course, it was optional, but if the popular appreciation of it increased, they would find, he hoped, that it would soon become a necessary part of education.

Mr. R. E. PANNETT (North Riding Technical Instruction Committee) said if Miss Hughes spoke of her opinions as heresies, he certainly was on the side of orthodoxy. If they were to take out of the elementary schools the subjects to which Miss Hughes objected they would be running the danger of making the education in primary schools too bookish, and he believed the object they all—Miss Hughes included—had in view would be better accomplished by including practical matters in the education rather than by eliminating them altogether. That view had impressed them very much in North Yorkshire, and a deputation from the three Ridings waited upon Mr. Acland, who, in a very important deliverance, which was not reported, said the Education Department would be prepared to give opportunities for practical teaching—for example, in cottage gardening in rural elementary schools. He believed that if that plan were followed, so far from the time thus used being detrimental to the acquisition of proper knowledge, it would make the scholars more interested in everything about them, and conduce to their being better prepared to benefit by technical education when the time came for them to receive it.

Mrs. PILLOW was very sorry to find herself in opposition to such an eminent authority as Miss Hughes, but she could not agree with her in saying that technical subjects should be taken entirely out of the elementary schools. What could be done with girls of 13 or 14 years of age who had never been taught the use of a needle, or how to cut out a garment? It would be a bad thing for our elementary school children if they received no technical education until they left the elementary schools. On the contrary, she thought they should include as much domestic science as possible in the curriculum. She had been lately brought into contact with many of the high schools of the country, and she had been disappointed by the answers and attitude of some of the head-mistresses, who seemed to be insulted at the suggestion that their girls should receive education in domestic subjects. It seemed a pity, for if head-mistresses looked at things from that point of view it could only be expected that girls would look at domestic science in the same light, and it would be very difficult to combat the prejudice that the study of domestic economy was undignified. She did not want them merely to be taught in a *dilletante* way, but certainly they should be taught to appreciate such education at its real and proper importance, and to understand that ignorance of the "why and wherefore" of the problems of home life was really undignified. The principles of domestic economy should be incorporated as part of the general education of the girls, and, where possible, actual practical instruction should be given.

Miss HUGHES, in reply, said she did not want to turn out practical work from the schools, but rather to develop manual dexterity in the schools giving a general education. She thought it was the increasing opinion of experts that sewing and cooking were, educationally, of very little value. There was something to be said for sewing and cooking, but from the practical side, and not from the educational one. It was sometimes said that if they could not be taught when the pupils were young, they could never be taught at all. That was ridiculous, because the best dressmakers in the world, she was ashamed to say, were men, who, she was sure, did not commence before 14 years of age. She thought the amount of time wasted in elementary schools upon sewing was disgraceful. She was sure that if they developed the child's mental dexterity in other and more educational ways, during school life, it would be able much better afterwards to take the training, which every woman ought to possess, in cooking, sewing, &c. Many of our English homes were at present badly managed by half educated women who had never learned their business. She believed the time was coming when no young woman would undertake to manage her own home, or anybody else's, until she had received a thorough training in such management, but that, she maintained, should come after school life when it could be given much better, and much more shortly—and she believed she would even live to see it.

The CHAIRMAN said the meeting had come to a close with a very interesting and characteristic speech by Miss Hughes, full of most refreshing heresies, which would set them all thinking upon matters about which perhaps there was too little thought. He could only express his regret that there had not been time for a more thorough discussion of the excellent papers before them. Happily, the papers would be printed and circulated, and they would then receive careful perusal. He was sure they would all heartily thank the ladies who had favoured them with their papers that morning.

SECTION B.

The Right Hon. Sir JOHN GORST, M.P., in the chair.

TECHNICAL EDUCATION IN INDIA: ITS CONDITIONS AND PROSPECTS.

PART I.—THE GENERAL CONDITIONS.

By J. A. BAINES, C.S.I.

In approaching the subject of this paper much ground has to be traversed which will probably be new and strange to those who are familiar enough with the conditions of technical education in modern Europe or America, where their evolution has been rapid, and is brought home to us by personal observation or by the circumstances of our everyday life. But, as regards India, we are brought face to face with a state of society so different in many important directions from that with which we are here familiar, that at the risk of inflicting a platitude on his audience, he must ask them to bear in mind that technical, like general education, in order to fulfil its object, to the utmost must be the outgrowth of the community which it is to benefit, and if imported in the first instance from abroad, unless it be adapted to the soil and not impatient of the modifications imposed by local conditions, it must remain an exotic, watered and tended under abnormal circumstances, under alien auspices and influence, which, the withdrawal of would deprive it of its sole chance of existence.

In regard to the organisation and development of not only technical education, but of its general social structure, the greater part of India is now very much in the stage in which Europe seems to have been towards the end of the middle ages. But the history of the latter brings us no lessons as to the probable course of events in the former, since we are dealing not only with an Oriental civilisation, but with one which, itself of a peculiarly stable character, has been suddenly brought into more or less close contact with the influences of the most energetic and progressive of modern types, and is not, therefore working out its destiny in its natural way, but on lines which it is assimilating from foreign suggestion. Nor, again, is India in a position to take advantage of more than a fraction of the example set before it by Western Europe. To begin with physical characteristics, the resources of India consist almost entirely of cattle and agricultural produce. Coal and iron, the chief essentials of modern industry, are found, it is true, but not to such an extent or of such a quality as to suffice for the support of wide-spread factorial enterprise. The tropical climate, again, is adverse to the concentration of large masses of artisans engaged with steam-power, and we must also allot due consideration to the fact that the same cause renders subsistence obtainable on comparatively easy terms, so that the attainment of a higher standard of living is by no means so powerful an incentive to enterprise and hard work as it is amongst the more hardy strugglers of the regions less favoured by nature. Other reasons, which will be touched upon later, combine to make the population of India essentially agricultural and rural in its proclivities, and to check that tendency towards congregation in towns and cities which is so marked a feature in the civilisation of the West.

The weakness of this tendency in India can be appreciated from the fact that scarcely 5 per cent. of the population is found in aggregates of 20,000 and over, and that these aggregates lie at an average distance of 90 miles from each other. The bulk of the people live in villages, having a mean population of no more than 360 each. The constitution of these units, or what is known as the village system, which prevails more or less uniformly over nearly the whole of the country, is not only one of the most interesting studies which Indian sociology presents, but is of the utmost relevance to the subject in hand, serving as it does to denote in a general way, the limits of the field open to the development of technical education. To put it as briefly as possible, the village is a certain definite area of land in the occupation of a cultivating community, the members of which, for safety and convenience, collocate their dwellings within it, instead of living each family on its farm. The nucleus of each village is the group of agriculturists, whether connected by tribe, blood, or merely by descent from the original settlers, amongst whom the lands are divided. These constitute the *raison d'être* of the community, and the rest are there to minister to their requirements. The aim of each village is to be self-contained and independent of all outside its boundaries. In the present day, owing to the development of the means of communication, and the efficient protection afforded by the British Government, this feeling of exclusiveness has been necessarily much weakened, but the framework of the original conception remains. All the simple needs of a cultivating community under tropical conditions, are provided for by the inclusion of certain recognised artisans, each with his definite position in the village hierarchy. The potter, carpenter, blacksmith, weaver, silversmith, as well as the personal services of the barber, find each their place, which the incumbent cannot advance; nor will the community allow him to suffer by the encroachment of others. The important points in connection with the present subject are, first, that these artisans and others are remunerated, as a rule, by either grants of a portion of the village land, which they are at liberty to till for themselves or lease to others of the community, or by a fixed proportion of the annual crops; and, secondly, that wherever, as a modern innovation, a service has to be paid in cash, the price is fixed not by competition, as no outsider is allowed to intervene, but by village custom. On the other hand, the artisan is essentially the property of the village, and, as a rule, does not seek to extend his *clientèle* beyond its limits. In old days this restriction was, in fact, a necessity imposed by the condition of the country. Even if the means of communication allowed of extensive commerce, the traveller possessed of valuable property was pretty sure to be made to stand and deliver, if not by footpads, by the roving bands of the State forces, who picked up a precarious living out of reach of the more disciplined *régime* of the chief town of their employer. The traders on a larger scale, passing from town to town, had not only to pay for the shelter of every village in which they passed the night, but were mulcted at every town and frontier in the shape of undefined octroi and transit dues, and had to arrange, moreover, for a fresh escort when passing through each petty state or chieftainship. In village life, then, there was little or no trade, properly so called, and therefore no production beyond the amount required by the village itself. It is not to be wondered at that the distribution of occupations was largely limited to the few industries comprised in the village system, and even at the present day nearly 80 per cent. of the population are found under those heads.

We have now to take into consideration certain features in the social system intimately connected with our subject. That occupations of the class just mentioned should descend in the same families from father to son is not peculiar to the village system in India, but, in that country, we have the additional fact of prohibition under religious sanction of any departure from the traditional occupation. The strength of the entire religious system of the Brahmanic hierarchy lies not in doctrine or dogma, but in caste, the rule of life in which absolute heredity is the predominant feature. Each individual inherits at birth the position of his father, and however he may improve his material position, it is impossible for him to vary, for better or worse, his social rank. It is within his own caste that he must marry and seek his social success. No one outside it may enter his house, sit down to meals with him, or receive his daughter in marriage. Similar restrictions apply to his occupation, though old tradition has sanctioned, in some cases, the choice of one among several of certain professions, and the carpenter's son may become a blacksmith, or even a mason, in the south of India. On the other hand, subdivisions are constantly arising within the caste itself, and a few families who have prospered and waxed proud often combine to intermarry only amongst themselves, and thus establish a superiority over their poorer brethren. A greater latitude in choice of occupation is in the present day allowed to the classes at the extremes of society than to the middle, and the Brahmans and writing castes undertake duties, within very definite limits, which were formerly unknown or prohibited to them. Similarly, and what is perhaps more pertinent to the subject, the labourers belonging to the menial or depressed castes, whose touch is polluting to the rest, have been the most ready to abandon the work of scavengers and field hands, which was formerly their only resource, for the more organised and lucrative employment in the comparatively few factories which have arisen within the last generation or two. There are well known instances, too, as in the cotton mills of Western India, and some of the jute mills in Bengal, where the middle classes of cultivators have discovered that they can engage, for part of the year at least, in factory work involving no violation of their scruples regarding ceremonial purity in the way of being called on to handle forbidden material, or work shoulder to shoulder with those whom they regard as outcasts in their native village. Such cases, however, are at present exceptional, and the tendency to abandon the paternal calling is hardly apparent among the great agricultural communities, and still less among the wide-spread classes of village artisans.

From the above outline of the more prominent features of the life of the masses, some notion can be formed of the length of time required before any system of education organised on the principles which commend themselves to modern Europe, can take root firmly and congenially in the popular mind. The isolating tendencies of the village community, the subordination of individual life to that of the family, and of individual enterprise to the iron rule of caste tradition, the discouragement of co-operation in the more elaborate industrial processes, and of competition in the supply of the simple necessaries of the existing standard of living, the cramping effect of heredity and custom reverenced to excess upon modification of that standard, and the glamour of religious sanction thrown over the most ordinary actions and events of everyday life, all these constitute social and economic drawbacks which can be easily appreciated. But it is scarcely necessary for one addressing an audience of experts such as we have before us, to say that there is another and a more favourable side to the shield, and that the very obstacles which have been mentioned have in them the germs of a devopment which, under judicious treatment, may reasonably be hoped to give adequate results in the required direction. The domestic industries which occupy the attention of the great bulk of the artisan population foster the system of apprenticeship to a degree which in the West is now but a faint tradition. The children are trained from their earliest years with the utmost care in the occupation to which, under caste rule, they are bound for life. Even the toys and pastimes of the younger members of the community are moulded upon the caste tradition. The budding cultivator ploughs the sand before his doorstep, and plots it out in miniature seed beds, or causes it to bloom with marigolds and other flowers picked from the paternal backyard. If, by a fortunate chance, a gutter or streamlet be at hand, it is conducted on to the estate in tiny irrigation channels engineered in imitation of those in use in the village lands, instead of being frittered away in the manufacture of mud pies. The infant carpenter handles the adze with care and skill in the manufacture of ploughs, sheds or bedsteads for his playmates, making over the chips to the scions of the blacksmith's house or the silversmith, for a small furnace, at which the potter, if admitted to the company, dries his pots and pans, to be set out before a rude copy of the village godling. Under this system of family training, form, pattern and process are maintained unchanged from generation to generation, and the skill necessary to keep up to the hereditary standard is never allowed to deteriorate. In certain art industries, indeed, the caste feeling is carried still further, and trade secrets are kept inviolate for centuries. For example, the enamel of Pratápgarh is a monopoly of this sort, so is a special form of silk embroidery in Surat, whilst the Kashmiri weaver, when labouring *in partibus*, retires to a solitary well to mix the dyes which have made his work celebrated throughout the two hemispheres, and records the patterns he has inherited in the minutest detail, but couched in a trade diction unintelligible to all outside the fraternity. Then, again, in addition to the inherited taste and aptitude thus developed and the almost instinctive accuracy and delicacy of touch acquired, the caste-system seems to implant a habit of concentrating the attention on the work in hand and an untiring patience which must turn out extremely useful when imported into work upon modern lines by the individual, but they are qualities, it is to be feared, which will hardly withstand the corroding influence of factorial co-operation, where the conscience is not stimulated in the case of the majority of workers by the satisfaction of contemplating their work in the fulness of its completed effect. It may be a whimsical suggestion, perhaps, but one not altogether devoid of probability, judging from what has happened already in somewhat similar circumstances, that in course of time the artisans engaged in the various sub-divisions of manufacturing processes may form themselves into separate castes, according to the grade of the work on which they are respectively specialised, and the blacksmith by caste who is engaged on boiler-fitting, will decline to intermarry with the family of his caste fellow who makes rivets, and the latter, in turn, look down upon the man who has stuck to the anvil or bellows. We have already the silk weaver who refuses communion with the weaver of cotton, and the weaver in colours who similarly rejects the social approaches of his kinsman who works in plain white; the gardener who grows fruit, who places himself above him who devotes himself to humble vegetables, and the carpenter who will neither intermarry nor sit at meat with the craftsman who repairs municipal rubbish carts, the reasons in the last case being sufficiently obvious to those who appreciate the Hindu sentiments with regard to external pollution. This fissiparous tendency is worth a passing comment, because it shows how the modern conditions of industry, instead of weakening the religion which regulates the social life of India, in reality, owing to the marvellous adaptability of that religion, is inclined to confirm it, whatever the extent to which new avocations may spring up, or the traditional occupations become modified by new circumstances. It is thus a characteristic telling in favour of the extension of the technical education, the taste for which it is to the advantage of the masses to develop.

It is here necessary to revert for a moment to a point to which reference has already been made in passing, namely, the comparatively weak influence of the town element in the population of India. That influence, indeed, is gradually spreading, and it is through it alone that technical education on modern lines can be transfused throughout the rural masses. But the growth of the town is of comparatively recent date. In old days, the only large cities were those in which a local ruler held his Court, and here alone could commerce and industry be sure of protection and patronage. As was observed 70 years ago, by that shrewd traveller, Victor Jacquemont, the French naturalist, the power of an Asiatic sovereign decreases with the cube of the distance from his capital; all wealth and enterprise, accordingly, was attracted under his wing. But Oriental sovereignty was proverbially evanescent. With the exception of the Rajputs of Central and Western India, not a single chief of importance is of the race of the bulk of his subjects, and, until the establishment of a strong paramount power, able to keep the peace, change of dynasty at frequent intervals was the rule rather than the exception. Along with the chief went the prosperity of his capital, and the new broom as often as not made a clean sweep of the memory of his predecessor by removing his head-quarters to a distance from the centre of the late local interests. It was but natural again that the industries which were chiefly promoted by the vicinity and patronage of a Court should be those connected with luxury and art rather than those fostered by the requirements of the masses. Hence the repute of the fine muslins, the "woven air" of Dacca, the jade and inlaid metal-work of Upper India, the gold-cloth of Ahmedabad, the shawls of Kashmir, and many other products destined exclusively for the gratification of taste and luxury, but unknown to the population at large. The demand for such industrial enterprise vanished, of course, with the Court on which it depended for its support, and the capitals of byegone dynasties have sunk into the position of the superannuated Belle, to whom the gifts of Ninon have been denied. In their place have arisen the seaport creations of British rule and the inland *ganglia* of the railway systems. It is to these only that the rustic seems to be attracted, more especially, as has been already indicated, those at the two extremes of society, the professional and the field labourer. It is here that, in obedience to modern tendencies, industry has been localised. Bombay, Ahmedabad, and Cawnpore utilise the cotton of the tracts of which they are the centres. Calcutta monopolises the manufacture of jute and lac, other towns are flourishing mainly on the preparation of raw material for export. The railways themselves, by which the transformation has been effected, give employment in their workshops to thousands of artisans under European training and supervision. From centres such as these the workers return to their villages with new processes, possibly new ideas, and, at all events, with a bundle of new tools, the advantages of which they are proud to expound to their stay-at-home elders. Indirectly, therefore, and very slowly, no doubt, but surely, the improvement of existing methods, the use of better material, and the demand for better results, are all permeating the village population which furnishes recruits to the small army of industry which finds employment in the factories of the great centres.

This, however, is little more than the first step on the road. The men thus influenced have learnt mechanically, and do not, of course, save in an altogether exceptional case, attempt to go beyond what they have been actually taught. The ground has not been prepared for further and spontaneous advance. By technical education something more is implied than the primary process of manual training, but the instillation of even rudimentary scientific principles requires the previous assimilation of what we may call the irreducible minimum of elementary education before the pupil is capable of appreciating, still more of applying, those principles. Here, then, we must take into consideration the almost universal intellectual torpor which broods like a dark cloud over all but the comparatively small professional section of the Indian population. People who are unacquainted with the social distinctions prevailing in that country and the nature of the barrier between them, and who estimate the condition of general education there by the calibre of the young men who pursue their studies at the Universities, or who complete their education in Europe, are bound to misjudge the situation, and to spread over the whole population the credit due to a very small class. Again, those who have before them the returns of the Indian Educational Departments are naturally struck with the large numbers therein displayed, as well as with the great increase in those numbers within the last quarter of a century or so, but do not take into consideration either the vast population from which they are collected, or the quality of the instruction, so far as it appears in the tables. These three points, however, are all important to the subject with which we are concerned, and it is no disparagement to the progress already made, or to the strenuous efforts to continue it on the part of those engaged in this great work, to look the facts in the face. Nor can it fairly be called the tone of a cynic or pessimist if on analysis the results are not praised without reference to the task still untouched. The first point to notice is that at the last Census no less than 94 per cent. of the population, including that of Burma, where education is more diffused than in the rest of the country, were returned as unable to read and write. Amongst the males, the proportion sinks to 89 per cent., but the fair sex show no less than 99½ per cent. Even more significant than these figures is the distribution, by race or caste, of those not illiterate, showing that out of 60 main groups into which the population, including Burmese and foreigners, are divided, only 11, amongst which are the Burmese and foreigners, show as much as 10 per cent. of their members able to read and write. The concentration of literacy is also to be inferred from the fact that the above-mentioned 11 groups comprise more than half the literates, but only 14 per cent. of the total population. Leaving out of consideration the women, the result is to bring in 20 groups instead of 11, comprising 18½ per cent. of the male population and 58½ of the literates of that sex. Of the agricultural group, 5, and of the artisans 4 per cent. of the males, are returned as not illiterate, and the only proportions which may be considered comparatively high are those of the Brahmans and writers, where they reach 30 and 43 respectively. These last, however, number little more than 4 per cent. of the population, so that, speaking of the population as a whole, it is not overstating the case to say that none but a few of the innumerable castes of the country have as yet shown any inclination to overcome their repugnance to book-learning. Here, again, it is the immoveable barrier of caste which has to be turned before substantial progress can be expected. In the eyes of the masses the three R's are no more than the tools by which the professional and trading castes get their living, instead of handling the plough, saw, or shuttle. Nor is there anything in the relative positions of the two sections which would induce the Brahman or writer to put the matter in any other light. It has been, indeed, the invariable policy of the Brahman when in power to withhold instruction, as far as possible, from the rest of the community, even from the castes of writers, who, however, being in many cases akin morganatically to the military class, managed to ensure their position at Court. The fear, openly expressed in Brahmanic writings of the middle and later ages of the pre-Musalman period, was that with the increase of knowledge, there might supervene diminished respect for the sacerdotal predominance. It is only since the firm establishment of British authority that systematic efforts have been made to diffuse the rudiments of learning among the masses, in the face of the apathy of the upper classes, and the unwillingness to break with tradition on the part of those for whose benefit the efforts are being made. Even now, in spite of the success which has attended the forty years' struggle, what has been said above shows clearly that it is the upper classes who have taken most advantage of the facilities afforded to all alike. The result has been the overstocking of the market in the direction of clerical work and the liberal professions, especially law, a result which is also responsible for much of the unsatisfactory condition of modern Greece, and which is showing a tendency, it is said, to become prominent in our neighbour across the Channel. In addition to this tendency to exalt a class to a position more and more removed from that of the masses, and a class, moreover, which has aims and sympathies by no means in harmony with those of the majority of their fellow-countrymen, there is one other point in connection with the statistics of education which needs a word or two of comment as bearing upon our subject. It is the astonishingly small proportion of the three millions or so of pupils on the rolls which has advanced beyond the elementary stage of instruction. No less than 93 per cent. are found under primary instruction, 6 per cent. under secondary, leaving only one per cent. in technical, training, and university institutions. When we consider the reluctance of the professional classes to engage in mechanical pursuits, and the insignificant numbers of other classes who have attained even the first stages of instruction, it is easy to see that much has yet to be done before a secure intellectual basis can be said to have been obtained for a general system of technical education.

It remains to summarise the conditions described above in order that it may be seen what advantages they present which may be utilised, and what difficulties to be overcome in diffusing such a system, and what form that system should take. Allowing that the movement in its favour must take its rise in the town, it must be remembered that it is in the country that its support must be sought, and from the village that it must derive its recruits, if it is to take root amongst the masses. The great majority of the population live, directly or indirectly, by cultivation, under conditions that make their needs few and simple. Their life is spent chiefly out of doors. The house is used for cooking, for a stable, but only in the winter and rainy season for shelter. Rent for it is unknown, but so are drainage and the importunate offices of the plumber. Tropical diet is not costly, and is mostly grown in the village itself, superfluity of clothes would be inconvenient, and variety, except in the luxury of female ornaments, is reprobated, fashion being dictated by caste tradition. Social ambition, again, must be limited according to caste injunction, and there is no outlet but in unproductive expenditure in caste feasts and pilgrimages. The poorest member of the caste consorts with the richest on terms of social equality, whilst the richest is not admitted within the door of the poorest of superior caste. The comparatively few requirements in the way of industrial products are met by handicraftsmen, who stand and fall with their patrons, are attached to each village in an assured position, and seek no custom beyond. Fixed to their craft by caste and a sort of guild fraternity, they learn their work early, devote themselves to it through life, and thereby acquire great skill, but little adaptability, except within narrow limits. Their work is done by rule of thumb handed down by their ancestors, and scrupulously maintained by them for the benefit of their posterity. They have, accordingly, no special reason for acquiring book learning, and are, like the peasantry, almost universally illiterate. General education has at present touched few classes of the community outside those with whom it is the traditional stock-in-trade, and who have for generations held it as their monopoly. Unfortunately, their inclination towards clerical work and one or two of the liberal professions has stood in the way of enlisting their intelligence, patience, and other good qualities in the service of industrial processes, where no doubt those traits would meet with appreciation and recompense.

It is obvious that, in these circumstances, the initial impetus to technical education in India must be given from the outside, and, in order that it may not remain, according to the metaphor used in the opening of this paper, an exotic, dependent entirely upon foreign support and care for its frail existence, it is necessary to discover the line of least resistance along which the State efforts in the required direction may be met halfway by the spontaneous inclinations of the masses. There appear to be two general tendencies, to which we may look for success in this respect. First, we have the appreciation of a higher standard of living, due to the great increase in the resources of the people for domestic expenditure which is a noteworthy feature of the last half century. It is, perhaps, inopportune to speak of this at a time when a great part of the country is in the throes of famine, but there is every reason to believe, judging by experience, that the check is but temporary, and that the progressive upward movement will resume its course when the scarcity is over. The steady increase of population, the improvement apparent to the most casual observer who has lived sometime in India in the dress, ornaments, household utensils, diet, and other personal attributes of the peasantry, together with the fact that the proportionate increase in the imports of merchandise during the reign of Her Majesty is far higher than that of the exports of produce and other goods,* all combine to indicate a demand which would undoubtedly be stimulated by an increased supply of equal quality from the hands of their own countrymen on local terms. On this point much will be said by Mr. Bhownaggree, in the paper which follows this, as his opportunities for observation have been recent and extensive.

We may look, in the next place, to an influence which will come into play at a later period, and in an opposite direction to that of increased means. In the course of time there must inevitably be forced upon the people the recognition of a fact which is even now apparent in one or two tracts in India, namely, that the pressure of an increasing population has been hitherto thrown entirely on the soil; that in most parts of the country the most fertile land has been brought under the plough, and that the limits of remunerative cultivation under the existing conditions, has been nearly reached. Further extension becoming impossible, recourse must obviously be had to one of two alternatives. Either an outlet for the surplus population must be found in some industries other than agriculture, or, by what is known as intensifying the cultivation by the application of the teachings of science, two blades of corn must be made to grow where only one grew before. Whichever course be adopted, the key of its success is to be found in the steady diffusion of a well-devised and well - organised system of technical education, adapted on the one hand to the literate, who can teach but not practice, and on the other, to the intelligent, but hitherto unlettered, mainstays of the village industries. The stalwart conservatism of the peasantry gives way in India, as elsewhere, before considerations of immediate advantage, provided that the benefit to be derived from the innovation be demonstrated beyond a doubt, for the ryot is both shrewd and cautious. Most of the agricultural improvements which have been suggested were rejected with some contumely until a close investigation of the circumstances on which the ryot formed his view and practice succeeded the assumption, previously adopted wholesale, that what was found an improvement in England must be equally advantageous in the tropics. That day is almost, if not quite, passed, and scientific observers have come to the conclusion that it is the system, not the detail, which requires modification. So with handicrafts, where the better results from the use of different tools or methods are duly appreciated in metal work and carpentry. The thin edge of many little wedges has been inserted between the past of custom and tradition and the present of individual judgment and trade advantage, but it is the combination of foreign impulse and native demand which alone can ultimately drive them home.

General Notes.

Ice in Venice.—The United States' Consul at Venice says that he has received information that a plant is to be established in or near that city for supplying the inhabitants with ice, artificially produced. The ice used in Venice is exceedingly impure; it is gathered from the ditches that are found on either side of the roads of the mainland, and that receive and hold in deposit, when not cleaned out by inundations, all the refuse from the adjacent farmhouses and villages. This ice, long recognised as absolutely unfit for domestic use, has now been declared by the Hygienic Board of the City to be a great menace to the public health. The steps so far taken are due to the Société des Eaux de Paris, which constructed and controls the aqueduct which furnishes the city supply of water. The quantity of ice consumed in Venice is on an average from 7,000 to 8,000 tons a year, and owing to the recent introduction of refrigerators and the continual increase in the number used, as well as to the growing consumption of beer, the amount of ice consumed is destined to increase rapidly.

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* Taking the imports of goods in 1837 as 100, those of 1896 will be 1,468. The corresponding figure for the goods exported is 1,032 only.

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HOWARD LECTURES.

THE MECHANICAL PRODUCTION OF COLD.

By Prof. J. A. Ewing, M.A., F.R.S., M.Inst.C.E.

Lecture I.—Delivered January 28, 1897.

Preliminary.

The Howard Lectures are primarily intended for the discussion of some application of thermo-dynamics. Previous lecturers have dealt with the generation and transmission of power, and I have been led to select the subject of mechanical refrigeration, on the double ground that it is one of the most interesting and comparatively novel applications of power, and that it is further intimately connected with the conversion of heat into work, inasmuch as it is simply the reversal of that operation—it is a conversion of work into heat, effected in such a way as to produce cold.

Its industrial importance is a matter on which I need not take up your time by dilating. One of its earliest and largest applications is to brewing. It is only by means of mechanical refrigeration that the great modern breweries have become possible. Moreover, it has revolutionised the industry which relates to the distribution and sale of ice. It has given us a product which is not only better than that which nature herself has provided, but can be sold at a price with which natural ice cannot in general compete. It has further created an enormous new industry in the transport and storage of the necessaries of life in a cold state. I do not suppose that many of us are aware how much we are indebted to it in this respect. That is a secret which must rest with our individual butchers. We can only conjecture that we sometimes owe something to mechanical refrigeration for the distribution of that "prime old English beef and mutton" for which we, in any case, pay home prices. It has given us many luxuries, such as paraffin wax, photographic films, and ice rinks. It has given us other things which I should hesitate to describe as luxuries, such as oleo-margarine. The commercial importance of mechanical refrigeration is indicated by the fact that there are two journals exclusively devoted to the subject, the American "Ice and Refrigeration," the German "Zeitschrift für die gesammte Kälte-Industrie." The first of these is garnished with the shrewd remarks and occasional agreeable personalities which are characteristic of the Transatlantic Press. The other is, in its way, just as distinctly national: fills one with a sense of the lead which Germany has over us in the matter of technical education. A great part of it is occupied by articles of the most substantial kind on thermo-dynamic theory, and it literally bristles with differential equations.

The subject is pre-eminently scientific as well as practical. In its whole development it has been guided to a remarkable degree by theory, and this has weighed with me in choosing it for treatment in these lectures. We may contrast it in this respect with the development of the steam-engine. That development, in its early stages, owed little or nothing to theory; it took place mainly by an empirical process. Heat-engines were brought to a considerable degree of perfection before even the doctrine of the mechanical equivalence of heat and work was realised. The case is different with mechanical refrigeration. At every step of the process we find the influence of scientific ideas. No part of it has taken place except under the direct guidance of physical science. If we turn to the writings of inventors on the subject—to the papers of Kirk, Coleman, Lightfoot, Linde, and Windhausen, we find the constant influence of scientific modes of thought affecting and directing their inventions. I cannot do better in this connection than quote language which was used by Sir Frederick Bramwell in the discussion on a paper by Mr. Coleman, read before the Institution of Civil Engineers in 1881. Sir Frederick Bramwell then said: "There probably never had been a paper submitted which made more perfectly clear the necessity that the successful engineer of the present day, and still more the successful engineer of the future, must be a man competent to apply to the pursuit of his profession the highest scientific truths. The subject," he continued, "showed how the very utmost results of thermo-dynamics were applied in practice for common use."

I propose, first, to go into a few general considerations regarding the thermo-dynamical basis on which stand all the practical processes of mechanical refrigeration. These considerations will, I am afraid, appear very dry, but they are essential to an understanding of the subject.

Broadly speaking, the methods that are employed for the production of cold may be classified under two heads. There is, first, the production of cold directly by the agency of heat, or, in other words, the expenditure of heat for the production of cold, and, second, the production of cold by the expenditure of mechanical work, and, therefore, in most cases, indirectly by the expenditure of heat, the heat being used first to produce mechanical power, which is then applied for the production of cold. Examples are of course found where some other source of mechanical power, such as water power, is applied, and where, therefore, the agency of heat does not come in at all. But in almost every practical example of refrigeration you find that heat is operative—that at one end of the chain you have the expenditure of heat going on, and at the other end you have the production of cold. Mr. Richmond, an American engineer who has written some highly interesting and suggestive papers on the subject, has remarked that if a student beginning to observe the process without any *a priori* ideas were to place himself outside an ice-making factory the first thing he would notice would be that coal goes in at one door and ice comes out at the other.

THE PRODUCTION OF COLD.

Now, what does this phrase, the production of cold, really mean? It implies, in the first place, the reduction of the temperature of a body below the general level of temperature of the surroundings. It further implies the maintenance of the temperature of a body at a lower level of temperature than the surroundings. Consequently, it means the continued extraction of heat from a body whose temperature is already below the temperature of bodies in its neighbourhood. For example, if a cold storage room is being maintained at a temperature of say 18° Fahr., there must be a continual extraction of heat from the atmosphere of the room. We must go on continuously pumping out the heat which comes into the room through leakage from outside, and also whatever heat is brought into the room in articles which are carried into it after the temperature has once been reduced. To maintain the temperature of a cold storage room you must have a continual extraction of heat going on from a thing which is already colder than its surroundings. Precisely the same remark is applicable in the case of a brine tank for the production of ice. The brine has to be maintained at a temperature somewhat lower than that at which water freezes, considerably lower if the process of freezing is to go on at a reasonably fast rate. The heat which comes into the brine from the water is to be frozen, the heat which the water gives out when it freezes, and the heat which leaks in from all sources has to be continuously extracted from the brine at this comparatively low level. What becomes of the heat so extracted? It is raised to a high level of temperature and discharged there. It is discharged by being given up to some substance which acts as a receiver of heat. In all actual cases of refrigeration this other thing which absorbs the rejected heat is circulating water, which becomes more or less warmed by the heat which it takes up. The machine works between two temperatures; the lower temperature at which heat is taken in from the body which is to be kept cold; and the higher temperature at which heat is rejected to the circulating water or other substance which absorbs it. In order that this process may go on we must have an expenditure of mechanical power. Heat is being virtually pumped up from the low level of temperature to the higher level, and is being rejected at that higher level of temperature. This process will not go on by itself; work has to be done to effect it. The work which is expended is itself converted into heat, and hence the whole quantity of heat which is rejected is made up of two elements. It is the heat which has been extracted from the low level of temperature plus the heat which is equivalent to the mechanical work expended in extracting it.

CO-EFFICIENT OF PERFORMANCE.

Taking the process as a whole, a quantity of work, which we may call W, is employed to extract at the low level of temperature a quantity of heat, which we will call Q_2. If Q_1 stands for the heat which is given out at the higher level, then these quantities are connected by the equation

$$Q_1 = Q_2 + W,$$

it being understood that the amount of work W is expressed by its equivalent in heat-units. As regards the efficiency of any process of refrigeration, what we are concerned with is the relation between the quantity of heat Q_2 which is taken in at the low level of temperature, and the quantity of work W which is expended in the process. If we take the quantity Q_2, and divide by W, we get a certain number which may be called the co-efficient of performance of the refrigeration. The co-efficient of performance of a refrigerating machine is defined to be the ratio of the quantity of heat which is extracted at the low level of temperature to the quantity of work which is employed in extracting it.

IDEALLY PERFECT REFRIGERATING MACHINE.

A fundamental question in the theory of refrigeration is this: What is the highest possible co-efficient of performance that any refrigerating machine can conceivably have? We shall afterwards have to consider how nearly the various practical refrigerating machines succeed in approaching this ideal of perfection. But our attention must first be given to the ideally perfect refrigerating machine whose co-efficient of performance is the highest conceivable. The co-efficient which is calculated for it is one which may be approached, but cannot possibly be exceeded by any real machine. It forms a standard of comparison by which the performance of real machines may be judged, so far as thermo-dynamic efficiency is concerned. The ideal performance of a refrigerating machine depends upon the particular temperatures between which it works. We shall see that under the ideally perfect conditions a simple relationship exists between the heat that is extracted from the cold body and the work which is done, which can be expressed as a function of the two temperatures between which the machine works, and that the greater the range of temperature is through which the heat has to be pumped up, the smaller does the ideal co-efficient of performance become. This, then, is a point of much practical importance. We cannot expect, even in the most perfect refrigerating machine, to find so large a co-efficient of performance in a case where the range of temperature through which the heat is to be raised is great, as we may find when the range is small; and practically it becomes of the utmost importance to keep the range of temperature as small as possible. In other words, we must aim at keeping the thing from which heat is to be taken at a temperature that is no colder than it is necessary for it to be, and we must aim at giving the heat, which is to be rejected, to something which is as cold as we can permit it to be. We must raise the heat through the smallest possible interval of temperature in order to get the highest co-efficient performance, in other words, to get the largest amount of refrigeration from a given expenditure of power.

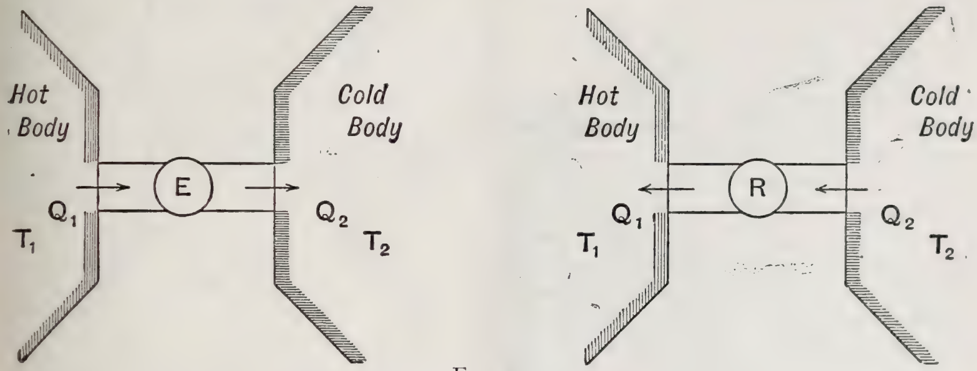

FIG. 1.

The co-efficient of performance of an ideally perfect refrigerating machine is readily found when we recognise that the operation of such a machine is precisely the reverse of the operation of a perfect heat-engine. In a heat-engine (E, Fig. 1) you have the heat coming in from some source of heat at a high temperature T_1, and going out to some cold body at a lower temperature T_2, and in its fall from the high temperature to the low, it does a certain amount of mechanical work. The heat Q_2, which goes out, is less than the heat Q_1, which comes in by the amount W of the work done by the engine. In the refrigerating machine (R, Fig. 1), the heat comes in at a low temperature, and goes out at a higher temperature, and in order to make it rise from the lower to the higher level of temperature it needs to have work spent upon it. In the case of the heat-engine, it is a familiar principle of thermo-dynamics that when the greatest possible amount of heat is being converted into work the ratio of Q_1, the heat which goes in, to Q_2 the heat which goes out will be the same as the ratio of the absolute temperature T_1, at which the heat comes in, to the absolute temperature T_2, at which the heat goes out. For brevity you will understand the word temperature to mean the absolute temperature, that is to say, the temperature expressed on the Fahrenheit scale plus the number 460, or, if you prefer to use the Centigrade scale, the temperature on that scale plus 273. In a perfect heat-engine, with the most ideally efficient means of converting heat into work, we have

$$\frac{Q_1}{Q_2} = \frac{T_1}{T_2},$$

and hence W, the work done, which is equal to $Q_1 - Q_2$ is such that

$$\frac{W}{Q_1} = \frac{T_1 - T_2}{T_1} \quad \text{or} \quad \frac{W}{Q_2} = \frac{T_1 - T_2}{T_2}.$$

This is the largest amount of work that can possibly be got by allowing heat to pass through a heat-engine from temperature T_1 to temperature T_2. The same quantity of work, which was the largest quantity that could be got out of the heat while the heat was flowing down, is the smallest quantity which will suffice to pump up. The ideally perfect heat-engine is a strictly reversible machine, and the work W, which was the work the heat produced when it was used as a heat-engine, is the same amount of work as just suffices to bring the heat through it backwards when we turn it into a refrigerating machine. This may be made plain by the use of a simple argument. Suppose we have (as in Fig. 2) a heat-engine E, and also a heat-pump or refrigerating machine R, both working between a cold body and a hot body. Assume that the heat-engine E is as efficient as is ideally possible. It takes in a quantity of heat Q_1, converts a portion of it into work W, and rejects the remainder Q_2 as heat. Now imagine that that work W is applied to drive the refrigerating machine without any loss between the two. If it were conceivable that the refrigerating machine R were more efficient than a reversed heat-engine, the work spent upon it, W, would extract from the cold body a large quantity of heat than Q_2, and would reject to the hot body a larger quantity than Q_1. Hence, on the whole, the cold body would lose heat, and the hot body would gain heat without expenditure of work from outside. That result is contrary to all experience, and would be a violation of the second law of thermo-dynamics. We cannot have heat flow automatically up hill. It can only be forced to flow up hill by the expenditure of energy. It follows, then, that a reversible heat-engine when reversed is the most efficient possible form of heat-pump. In other words, that the largest quantity of work which can be got out of a perfect heat-engine is the smallest quantity of work which will suffice to force heat through the engine in the opposite direction from the cold body up to the hot body.

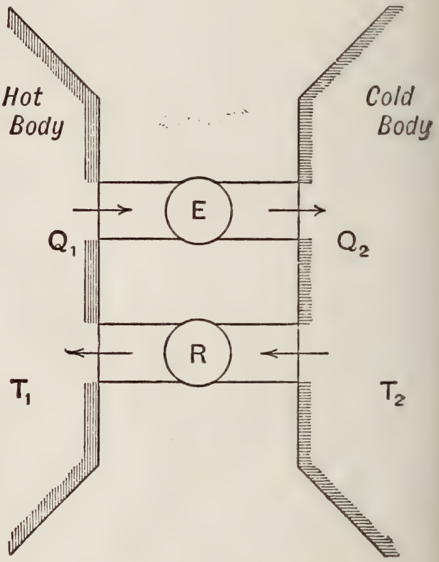

FIG. 2.

REVERSIBILITY.

Reversibility, in the thermo-dynamic sense, is the criterion of perfection in the refrigerating machine, just as it is in the heat-engine. The full amount of refrigerating effect, for a given expenditure of work, is obtained only when this criterion is satisfied. To obtain it, the substance which serves as the medium by which the heat is conveyed through the system should take in no heat except at the lowest level of temperature, and give out none except at the highest level of temperature. Further, the actions which go on within the machine will be reversible only when there is no unresisted expansion on the part of gas or vapour or any other working substance. Any passage of gas or of liquid through a throttle valve is an essentially irreversible action, and is, therefore, inconsistent with the highest efficiency. In practice we cannot hope to do more than approximate to the ideal of reversibility, but it is easy to imagine a series of operations in which everything is strictly reversible, and in which also the condition is satisfied that all the heat which is taken in shall be taken in at the lowest level of temperature, and that all the heat which is given out shall be given out at the highest level of temperature. Students of thermo-dynamics are familiar with the cycle of operations which was first described by the French philosopher, Sadi Carnot. This is a reversible cycle for the conversion of heat into work, and we have only to imagine it reversed in order to have, in imagination, an ideally perfect refrigerating macnine.

CARNOT'S CYCLE REVERSED.

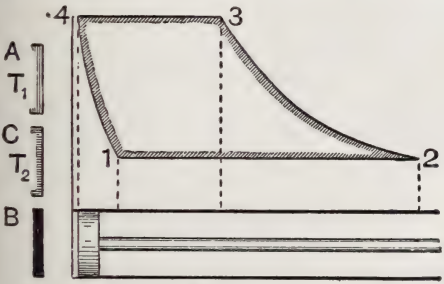

FIG. 3.

Imagine a cylinder and piston (Fig. 3), made of non-conducting material, except that the bottom of the cylinder is a conductor. Suppose further that we may fit to the bottom of the cylinder either the cold body C, from which heat is to be extracted, or a warmer body, A, to which heat may be rejected, or a non-conducting cover, B. At the beginning of the process we have in the bottom of the cylinder a quantity of liquid at the same temperature T_1 as the warm body A. The first operation is to apply the non-conducting cover B, and allow the piston to rise. As it rises the liquid begins to evaporate, and its pressure and temperature both fall. Let this go on until the temperature of the substance, which is now a mixture of liquid and vapour, has fallen to the lower level of temperature, T_2. On the indicator diagram which is sketched above the cylinder in Fig. 3 this part of the process corresponds to the line 4,1. This action has gone on without any introduction of heat from outside—in other words, it is what is called in thermo-dynamics an adiabatic action. Next, let the non-conducting cover be removed and the cold body be put in contact with the bottom of the cylinder, the contents of which are already at the temperature T_2 of the cold body, and let the piston continue to rise. The substance goes on evaporating under the constant pressure corresponding to the temperature T_2, taking in heat from C. This part of the process is shown by the line 1,2, which indicates the change from a state in which there is very little vapour and much liquid to a state where much of the substance has been vaporised. We might continue this process until all the liquid has turned into vapour, but it is more convenient to suppose it stopped while there is still some liquid present in the mixture. When the stage 2 has been reached let us replace the non-conducting cover after removing the cold body and begin to force the piston down. This compresses the substance adiabatically, and consequently makes its temperature to rise. Through this process certain changes take place in the proportion of liquid and vapour. If we have a perfectly dry vapour at point 2, then it will be superheated by the compression, but if we have left a sufficient mixture of liquid with the vapour it will remain saturated during compression. In that case the mixture becomes drier as we compress it—that is to say, the proportion of liquid to vapour becomes reduced. This process is continued until, at the point 3, the temperature has risen to T_1. The simplest supposition to make is that we have stopped the process 1,2 at such a point that when we compress the mixture it takes the condition of dry saturated vapour when this process is completed at the point 3. Then apply the warm body A in place of the non-conducting cover and continue the compression. During this final process the vapour is further condensed, giving out heat to A, and remaining at the temperatue T_1. The whole cycle of operations is completed at point 4, when the working substance has been brought back to the condition in which we supposed it to be at the first. Observe that in all this process there is only one time when heat is taken in, viz., the stage 1, 2, and only one time when heat is being given out, viz., the stage 3, 4. While the heat is being taken in the working substance has already been brought to, and is continuously kept at, the temperature of the cold body T_2, and all the while that heat is being given out the working substance is continuously at the temperature of the warm body, T_1. The conditions of reversibility are satisfied. In the whole of the action there is nothing of the nature of unresisted expansion. There is no passing through a throttle valve, nothing to interfere with reversibility either as regards the mechanism of the process, or as regards the transfer of heat. If we could make a refrigerating machine act in this way it would be an ideally perfect machine, and its co-efficient of performance would have the ideally highest value. The ratio of the heat taken in to the work done, or $\frac{Q_2}{Q_1 - Q_2}$, which is the measure of the co-efficient of performance, would in that case be equal to $\frac{T_2}{T_1 - T_2}$ The performance would be entirely dependent on the two temperatures, and would be the same whatever working substance was used in the cylinder. This ideal co-efficient, $\frac{T_2}{T_1 - T_2}$ is a number much greater than unity in most cases. So long as the range of temperature, T_1—T_2, is not very great, the number which we get by dividing T_2 by T_1—T_2 will be large. In the table a series of numbers are given which show the values of this expression $\frac{T_1}{T_1 - T_2}$ for various assumed temperatures. These are the ideally highest co-efficients of performance which can be reached in any process of refrigeration.

CO-EFFICIENTS OF PERFORMANCE OF A PERFECT REFRIGERATING MACHINE.

Lower Limit of Temperature T_1 in Deg. Fah.	Upper Limit of Temperature T_2 in Deg. Fah.					
	50°	60°	70°	80°	90°	100°
—10°	7·5	6·4	5·6	5·0	4·5	4·1
0°	9·2	7·7	6·6	5·8	5·1	4·6
10°	11·7	9·4	7·8	6·7	5·9	5·2
20°	16·0	12·0	9·6	8·0	6·8	6·0
30°	24·5	16·3	12·2	9·8	8·2	7·0
40°	50·0	25·0	16·7	12·5	10·0	8·3

For example, suppose you were refrigerating from a temperature of 20° Fahr., and rejecting heat at 60° Fahr., the ideal refrigerating machine would have a co-efficient of performance of 12, that is to say, you could get 12 times as much heat extracted from the cold body as you applied to the machine in the form of work, whereas, if you were pumping up the heat to the higher level of 100° Fahr., and extracting it from the low level of – 10° Fahr., then the amount of heat extracted could not exceed 4·1 times the amount of work done. Taking the perpendicular columns, it is seen how the refrigerating effect of a given amount of work depends on the temperature of the thing from which the heat is being absorbed. Taking the numbers horizontally, it is seen how the same quantity depends on the temperature of the condensing water, that is to say, on the temperature to which you are obliged to raise the heat in order to get rid of it.

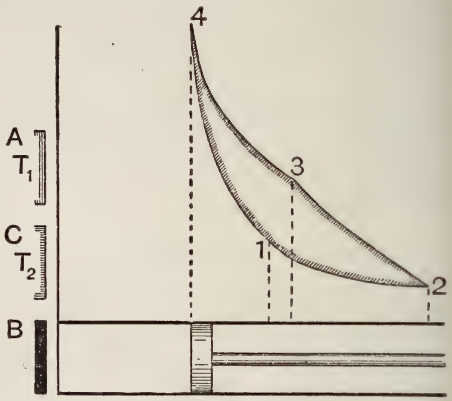

FIG. 4.

In Fig. 4 we have an example of this same Carnot cycle, but with air as the working substance instead of liquid and vapour. The form of the indicator diagram is very different, but the four processes which make up the cycle are exactly the same as before, and the co-efficient of performance, depending, as it does, only on the temperature, has, of course, the same value, namely $\frac{T_2}{T_1 - T_2}$.

ENTROPY DIAGRAM.

Instead of using the indicator diagram to exhibit any such cycle we shall sometimes find it of very great service to use what is called the entropy temperature diagram. In the entropy diagram, as in the indicator diagram, quantities of heat and work are represented by areas, but one of the co-ordinates of the entropy diagram is temperature, and consequently the other co-ordinate, the entropy, is a quantity of the dimensions of heat divided by temperature. We may define sufficiently for our present purposes this word "entropy" in the following way. If a body takes in or gives out heat at any temperature, the quantity of heat taken in or given out, divided by the temperature at which it is taken in or given out, measures the amount by which the body changes its entropy. In an adiabatic process the entropy does not change, because no heat is being taken in or given out. Consequently an adiabatic process will be represented on the entropy-temperature diagram by a vertical line, whereas an isothermal process, that is to say, a process in which heat is taken in or given out at a constant temperature, will be represented by a horizontal line. The four stages of the Carnot cycle consist of two adiabatic stages, and two isothermal stages. The entropy temperature diagram for the Carnot cycle will therefore consist of two vertical lines and two horizontal lines (Fig. 5), and this will be the form of diagram whatever be the substance that is taken through the Carnot cycle. The indicator diagrams are very different in Figs. 3 and 4, but the entropy diagram of Fig. 5 applies equally to both. We shall have occasion to make much use of entropy temperature diagrams when we discuss the action of real refrigerating machines.

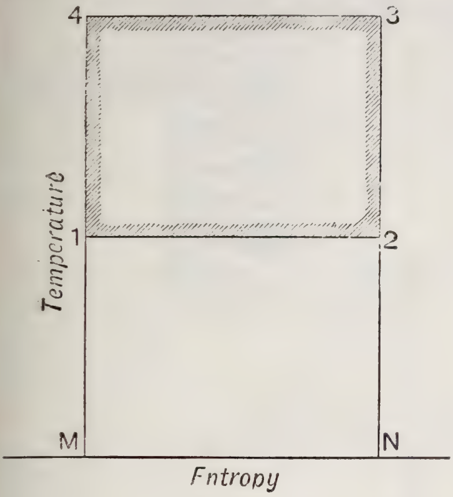

Fig. 5.

Refrigerating Machines with Separated Organs.

In this imaginary cycle we have supposed the whole of the action to be going on within a single vessel. The cylinder serves not only for the expansion and compression of the substance, but also as condenser and evaporator. In actual refrigeration it would be impracticable to have all the different parts of the process performed in a single vessel. The imaginary engine of Fig. 3 resembles those primitively simple living things in which a single organ serves all the purposes of stomach, heart and brain. As you ascend in the scale of life you find more and more complexity, separate organs being evolved to discharge separate functions. From the primitive Carnot engine with its single organ, we may proceed to imagine a more practicable refrigerating machine in which each of the four stages of the process has an organ to itself. Suppose there is, as in Fig. 6 (p. 994), a separate cylinder for compression, and another for expansion, separate vessel C in which the substance is taking up heat, and another A, in which it is giving out heat. You may conceive of C as a tank containing brine which is to be kept cold, and A as a condenser in which the heat given out by the working vapour as it condenses is absorbed by circulating water. The condensed vapour passes from A into the expansion cylinder, and is diabatically expanded there until the temperature falls to that of C. It is then discharged into C, and is further vaporised, thus taking up heat from the brine; it then passes on to the compression cylinder, is adiabatically compressed until its temperature rises to that of A, and is then delivered to A, being isothermally compressed while it condenses there. Thus a cycle identical with that of Fig. 3 might be gone through with the engine of Fig. 6. In practice, however, the refrigerating machine as it is exists does not have all these organs. Where we are dealing with liquid and vapour, the universal practice at the present time is to omit one of the organs, namely, the expansion cylinder, and in consequence of that we have an action which is not identical with the Carnot action, but is thermo-dynamically a less perfect action. The condensed vapour is allowed simply to stream through a throttle valve from the condenser to the refrigerator, without doing work on the way in an expansion cylinder. We shall discuss this point more fully in a later lecture, but I may say now that two things follow from this modification of the cycle. In the first place, the amount of work which has to be expended on the material in carrying it through the whole cycle becomes slightly greater because the work which would be recovered in the expansion cylinder is not recovered, and, in the scond place, the amount of heat which is extracted from the cold body C becomes somewhat less, because the liquid is not cold by expansion before it enters C, and consequently it carries with it a quantity of heat into the refrigerating chamber or tank, and so diminishes the amount of net or effective refrigeration.

Use of Regenerator.

The Carnot cycle, carried out in its entirety, which it never is in practice, is one means by which we might have a perfect refrigerating machine, and get the theoretically greatest amount of refrigeration from a given expendi-

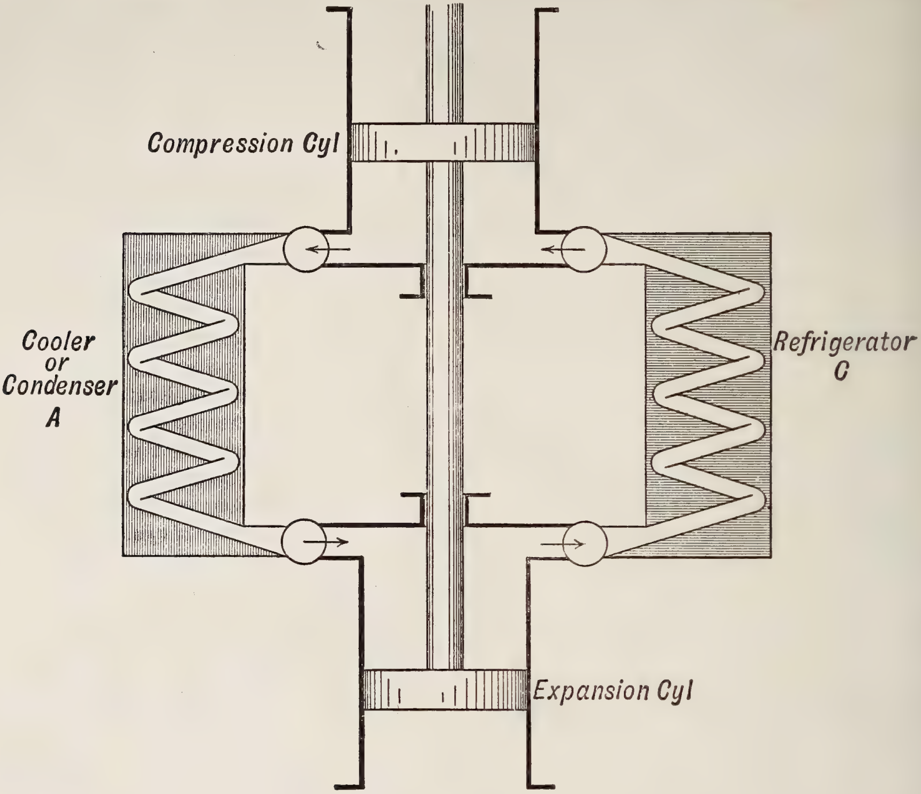

FIG. 6.

ture of work. But there is one other means by which we might, in theory, have a perfect refrigerating machine. Besides the Carnot cycle there is one, and only one other possibility of getting thermo-dynamical perfection. It is by taking advantage of an old invention made in 1837 by a Scottish minister, the Rev. Robert Stirling. Students of thermo-dynamics are familiar with the Stirling hot-air engine, in which the working substance is made to pass alternately in one direction and another through what is called a regenerator, generally consisting of a quantity of wire gauze, or any other substance capable of taking up heat from the working substance when it passes through it in one direction, and then giving back that heat to the working substance when it passes through it in the other direction. In the Carnot cycle the characteristic is that the change from high temperature to low temperature, and again from low temperature to high temperature, is performed in each case by adiabatic expansion or adiabatic compression. In the Stirling engine the corresponding changes are performed by passing the working substance through the regenerator, and the characteristic of that action is that the heat which is deposited by the substance in the regenerator is taken up again—in theory entirely, in practice partly—as it comes through it in the other direction. By an action of this kind it is possible to have thermo-dynamically

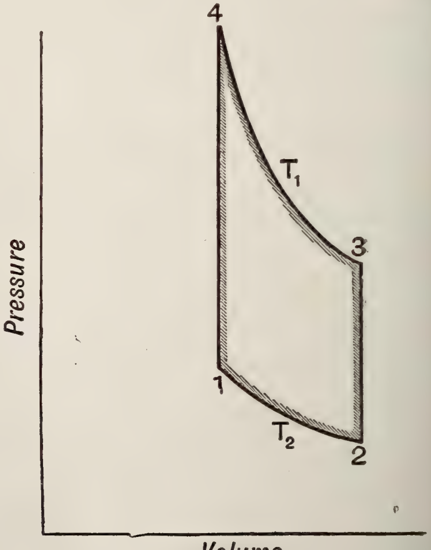

FIG. 7.

the equivalent of the Carnot cycle, although the operation is in this respect different. The indicator diagram given by a gas in passing through a perfect cycle in which a regenerator is used in place of the two adiabatic stages, is given in Fig. 7 (page 994).

Fig. 8 is the corresponding entropy diagram. In both figures the lines 4,1 and 2,3 show gas passing through the regenerator, giving up heat to it when passing in one direction, and recovering that heat when passing in the other. If all the heat deposited in the regenerator were picked up again, and if the cycle were in other respects reversible, it would be as efficient as the Carnot cycle. In practice, however, a regenerator cannot be made to store and restore heat without loss.

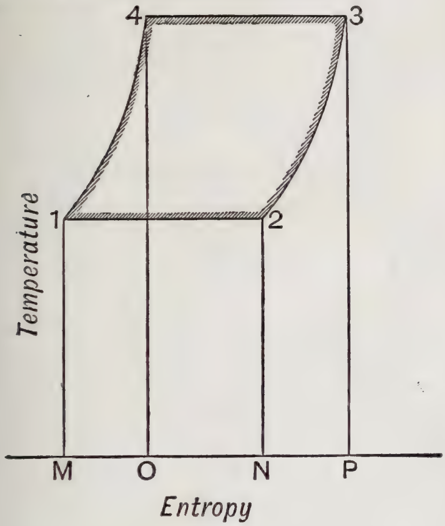

FIG. 8.

In one of the earliest of practical refrigerating machines a regenerator was actually used. In Kirk's air machine, which will be mentioned more particularly in my next lecture, the endeavour was made to approximate to the ideal performance not on the lines of the cycle of Carnot, but on those of Stirling, using a regenerator.

THE AREAS IN THE ENTROPY DIAGRAM.

The entropy diagram has this great merit, that it shows at a glance, not only the work which is being expended on this substance in taking it through the cycle, but also the amount of heat that is taken up at one part, and the amount given that is out at another. In the Carnot cycle (Fig. 5) we have not only the area of the rectangle, 1, 2, 3, 4 representing the amount of work that is expended on the substance, but the area underneath, namely, the rectangle 1,N represents the amount of heat which is taken out of the cold body, and the area 4,N represents the amount of heat which is rejected to the warmer body. Thus the diagram shows by three different areas the three quantities which we are concerned with, the quantities which I have described by the letters Q_1, Q_2, and W, or $Q_1 - Q_2$.

Again, the entropy diagram shows plainly how important it is to make the range of temperature narrow, and especially to keep the cold body no colder than is necessary. In the entropy diagram of Fig. 9, an area representing one definite quantity of work is sketched in three different conditions of temperature, always having the same uper level T_1, but with three different values of the lower temperature T_2. The amount of refrigeration which the same amount of work is theoretically capable of performing is shown by the rectangle CD in one case, by the larger rectangle BD in the next case, and by the very much larger rectangle AD in the third. If we allow the level from which we pump up the heat to be too low (as at *c*), we get only this very moderate amount of refrigeration CD. If we allow it to be high, not very far from the temperature at which we have to reject the heat (as at *d*), we get with the same expenditure of work the enormously larger quantity of refrigeration represented by the rectangle AD.

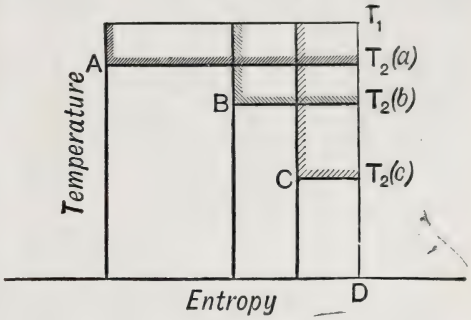

FIG. 9.

The practical moral of this is plain. Not only should the cooling water be as cool as possible, and not only should the working substance be heated to no higher temperature above the level of the cooling water than is necessary, but, besides that, we should avoid having the lower limit any lower than can be helped. Suppose, for instance, that the problem is one of cold storage, let us say, and we are using ammonia as our refrigerating medium; if we allow the store to be kept cold by the direct evaporation of ammonia in pipes which are placed in the store, we shall in general be absorbing heat at a higher temperature than if we were first of all to apply the evaporation of ammonia to cool a tank of brine, and then make the cold brine circulate through the store. In the second case, the communication of heat to the working substance is less direct, for there are two steps to be passed. The heat has to go from the air of the store into the brine, and then from the brine into the ammonia, and in each of these steps there must be some difference of temperature in order that the heat may flow across the conducting surface, which separates the one substance from the other. In the other case there is only one step, the air giving up its heat directly through the pipes to the ammonia, and, consequently, the extent by which the ammonia needs to be lower in temperature than the air of the cold chamber may be expected to be less.* Anything that lessens this interval of temperature lessens the amount of work that must be spent in maintaining the refrigeration. I do not, of course, mean to suggest that there are no circumstances in which brine circulation is not advantageous. There are many practical points to be considered besides this question of thermo-dynamic efficiency.

DIRECT APPLICATION OF HEAT TO PRODUCE COLD.

I have still something to say about the production of cold by the application of heat instead of by the application of mechanical power. There are certain types of refrigerating machine where there is no visible application of mechanical power at all; where you are simply giving heat to the machine from a high temperature source, and the result of this is to pump heat up from a low temperature to another temperature at which it is rejected. The ammonia absorption machine is a familiar practical example of this class. There you have three temperatures to consider; the temperature T, at which the high-temperature heat is supplied, the low temperature T_2 of the cold body from which the heat is being extracted, and the intermediate temperature T_1, at which heat is being rejected. Diagrammatically we may represent the matter in this way (Fig. 10). Any machine which directly applies heat to produce cold, may be regarded as equivalent to a combination of motor, or heat-engine, and refrigerator, or heat-pump. A quantity Q of high-temperature heat goes in at one place, a quantity Q_2 of low-temperature heat is thereby caused to go in at another place, and there is an intermediate temperature T_1 at which heat is rejected. The heat which is rejected is equal to the sum of Q and Q_2, for there is no work done by the machine or spent upon it. An important practical question with regard to such a machine, is what is its ideally best performance. What is the ratio which exists in the most favourable possible circumstances between the high-temperature heat Q that goes in at one end, and the low-temperature heat Q_2 which is thereby extracted from the cold body at the other end? If we imagine the machine really to consist of a perfect heat-engine driving a perfect refrigerating machine, it is easy to calculate this ratio when the three temperatures are assigned. The quantity of heat Q supplied at temperature T, and working between that temperature and T_1, is capable of doing an amount of work W such that

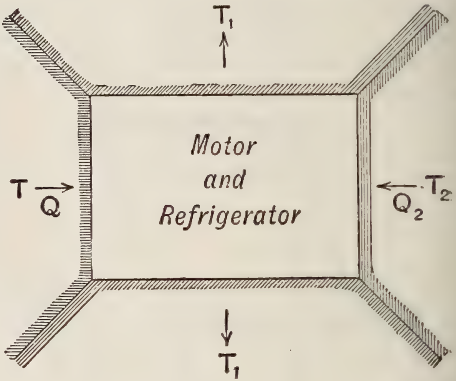

FIG. 10.

$$W = \frac{Q\,(T - T_1)}{T}.$$

Then the work W, applied to drive a perfect refrigerating machine which works between the temperatures T_2 and T_1, is capable of absorbing from the cold body an amount of heat Q_2 such that

$$W = \frac{Q_2\,(T_1 - T_2)}{T_2}$$

since $\dfrac{T_2}{T_1 - T_2}$ is the co-efficient of performance.

Hence the greatest refrigerating effect which such a combination of perfect heat-engine and perfect refrigerating machine could produce is given by the equation

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* It is, however, possible to arrange matters so that the use of brine may actually reduce instead of increasing the interval of temperature. If brine is made to drip over the ammonia pipes, and air is blown past the dripping brine, the air is brought nearer in temperature to the ammonia than it usually is in direct ammonia circulation.

$$Q_2 = \frac{Q\,T_2\,(T - T_1)}{T\,(T_1 - T_2)}.$$

But the question arises, is there any imaginable way of applying the heat Q so as to produce a greater refrigerating effect than this, the temperatures remaining as before? The answer is no. The combination of a reversible heat-engine with a reversible heat-pump affords a means of utilising heat for the production of cold, which cannot be surpassed in efficiency by any other imaginable contrivance. To prove this it is only necessary to apply the method of argument already used, and to think of the combination as reversed, delivering heat Q to the body at T, and also delivering heat Q_2 to the body at T_2. Then, if any other contrivance could be more efficient, it would, using the same high temperature heat Q, remove more heat than Q_2 from the cold body. Hence, on the whole, the cold body would lose heat, while, on the whole, the hot body would lose none. In other words, we should then have the impossible result that heat would, without expenditure of work from outside, form the cold body at T to the warmer body at T_1, the intermediate temperature. The conclusion is that no type of refrigerator using heat directly as the agent, such, for instance, as an absorption machine, can give a higher ratio of Q_2 to Q than is expressed by the above equation. In point of fact, no absorption machine gives nearly so good a return for its heat as this, for the absorption machine has an action that is not reversible, and, moreover, it rejects heat at temperatures higher than the temperature of the circulating water. Any heat rejected at temperatures higher than T_1 implies a sacrifice of efficiency.

The entropy diagram may be used to illustrate the most effective means of applying heat to produce refrigeration. In Fig. 11 the rectangle RO is drawn to represent the high temperature heat which is supplied, and the rectangle RT shows the work which would be done by a perfect heat engine receiving heat at T and rejecting heat at T_1. Let T_2 be the temperature of the cold body from which heat is to be extracted. Draw a rectangle QT_2, equal in area to RT_1. Then the rectangle T_2N measures the amount of refrigeration which can, under ideally favourable conditions, be effected by the heat RO. When T is high, and T_2 not much lower than T_1, it is clear that the supply of heat RO may be much less than the refrigerating effect T_2N. Ideally, therefore, a given quantity of heat in coming down from the high temperature may cause much more than an equal quantity of heat to be pumped up from the low temperature. In practice, however, absorption machines pump up less heat than they take in.

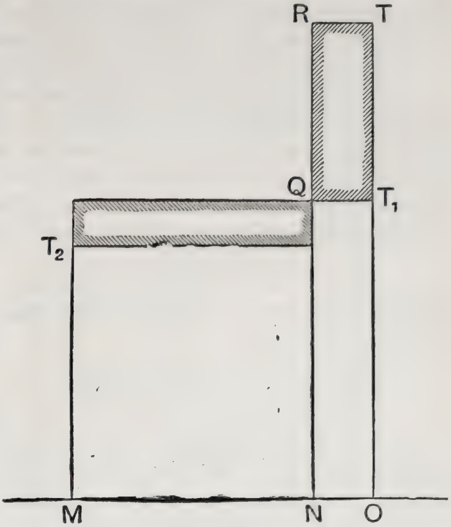

FIG. 11.

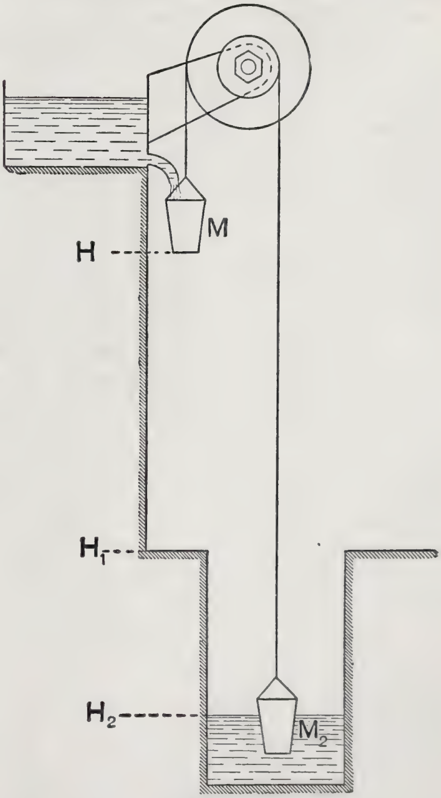

FIG. 12.

The mechanical analogy indicated in Fig. 12 may help to make the ideal process plain. Here a quantity of water, M, is supplied at a high level, H, and does work in falling to a lower level, H_1. The work is applied to raise another quantity of water, M_2, from a still lower level, H_2, up to H_1. The water that has come down from the high level, doing work, as well as the water that has been raised from the low level, is allowed to flow away at the level, H_1. The quantities are connected by the equation

$$M (H - H_1) = M_2 (H_1 - H_2)$$

Comparing this with the equation given above, which may be written

$$\frac{Q}{T} (T - T_1) = \frac{Q_2}{T_2} (T_1 - T_2),$$

we see that if temperature be taken as the analogue of level, the thing which is the analogue of quantity of water is not simply heat, but heat divided by the temperature at which it is supplied : in other words, entropy.

THE REFRIGERATING MACHINE AS A MEANS OF WARMING.

An interesting fact is to be noted before we leave the consideration of Fig. 10. The combination of heat-engine and heat-pump imagined there has the effect of delivering to the middle region at T_1 a quantity of heat equal to $Q + Q_2$. Now, suppose the space at T_1 is a room which is to be kept somewhat warmer than the outer atmosphere, and that the temperature outside is T_2. A comparatively small quantity of high-temperature heat, Q, applied in this way, will serve to deliver to the room a very much greater quantity of low-temperature heat. This was pointed out as early as 1852 by Lord Kelvin, who showed that in the warming of rooms it would be in theory much more economical to apply the heat got from burning coal in this way, than by directly discharging it into the room that is to be warmed. The value of high-temperature heat is in great measure wasted if we allow it to enter a comparatively cold substance. The way to utilise it to the best advantage is to drive a heat-engine, and let that in turn work a heat-pump, which will lift a much larger quantity of heat from the surrounding level of temperature through the small range that is required. To use a coal fire in warming a room is, from the thermo-dynamic point of view, a piece of prodigality, and it would still be prodigal even if we did not, as we do, allow most of the heat to escape by the chimney.

International Congress on Technical Education.

FRIDAY, 18TH JUNE.

SECTION B.—*(continued)*.

The Right Hon. Sir JOHN GORST, M.P., in the chair.

TECHNICAL EDUCATION IN INDIA.

PART II.—PRESENT CONDITION AND PROSPECTS.

BY SIR M. M. BHOWNAGGREE, K.C.I.E., M.P.

Of all the numerous subjects which a well-wisher of India is called upon to take into his serious consideration, there is none of such surpassing interest and importance as that of her industrial development, and as it is now a universally accepted principle that the growth of industries among a people is in proportion to their instruction in the sciences and arts applicable to their practical pursuit, the theme of technical education in India is one which, from reasons which will appear later on, I approach with much deliberation and with a certain feeling of anxiety. I must at once premise that the reflections which the subject presents in its economic, political, and educational aspects are so varied and vast that I could not pretend to deal with them here exhaustively. The multiform diversity of the ethical, physical, religious and social conditions of the country and of the races inhabiting it, require the elucidation of propositions and exceptions with peculiar reference to the different provinces and castes, which the limits of this paper will not permit of my attempting in detail. In the absence of such special treatment of the subject, the information I convey and the conclusions I draw in the course of this paper might seem here and there open to doubt and objection, but when it is remembered that I am speaking in one breath as it were of a country not far short of two millon square miles in extent, inhabited by a congeries of nearly three hundred millions of vastly diversified races of people, I cannot well be expected to treat the subject in any more definite and specialised, or rather less general method than that which I have chosen to employ. It is the only method possible in dealing with so vast an amount of matter in so short a space of time as is placed at our disposal.

The preliminary observations, before arriving at the point from which one can fairly consider whether the present means of technical education in India are adequate or otherwise, which I should have had to make, are happily embraced in the paper which has preceded mine, and of which I must ask you to consider this a continuation, although of a very inferior quality. You have had from a facile writer of considerable Indian experience, who has been for years a keen observer and judge of the varied conditions of her different provinces and peoples, some very sound views as to the circumstances which would demark a system of technical education in India from that adopted in Europe. Mr. Baines has told you of the want of coal and iron, of the simple needs of the people, of their indisposition to migrate to industrial centres from their agricultural village homes, of the limits which religion and custom place on their aspirations, and on healthy inter-racial competition, and of other such causes unfavourable to the dissemination of technical instruction. On the other hand, he has given graphic and comprehensive information as to how the caste system of the people can be utilised in improving workmanship, and enlarging the sphere of labour generally, and how it lends itself to conditions of co-operative work in factories. He has also pointed out what incentive is furnished by the rising standards of life, and the enormous imports of foreign manufactures, for the production of articles of daily use or consumption. Further, he has indicated how the extension of general education, and the growth of Western notions as to the objective of industrial labour being the common weal of the country, instead of mainly contributing, as it did in former times, to the pride and luxury of the ruling and aristocratic classes, are designed to prepare large communities to burst the bounds of hereditary employment within fixed and orthodox limits and to proceed to the extension and application of the principle of science and art to practical pursuits, or, in other words, for the reception of technical education in its widest and best sense.

Starting from the platform thus prepared for us, I propose in the first place to enlarge upon those conditions of Indian life which will enable us to realise whether, and how far, the habits and wants of her people at the present day demand a supply of such articles as require in their manufacture skilled labour based upon technical instruction. Of the 288,000,000 of people who form the population of the country, it is roughly reckoned that 180,000,000 are agriculturists. If we entirely exclude this great subdivision of her inhabitants from the classification mentioned in the preceding sentence, and regard it as offering no market for manufactures of skilled industry, we still have upwards of 100,000,000 of people, or three times the whole population of the United Kingdom, who might fairly be assumed in varying degrees to take such articles into daily use. In respect of the agricultural population, too, it must be remembered that they afford a vast field for the consumption of rough cotton and woollen fabrics, which are at present supplied to a large extent by hand-looms. This might seem strange to those who have heard of the large cotton spinning and weaving steam factories of India, but that these mills do not compete with the hand-looms to such an extent as to drive the worker at those crude primitive machines out of existence might not unreasonably be assumed to point to the fact, that even in the one industry, which is mistakenly supposed to be fully developed in India, there is enough scope for much further development by means of such technical instruction as might ultimately tend to cheapen the manufactured article, thus enabling it to replace the slow production of the hand-loom. This subject I must confess, admits of some controversy, and therefore, after contenting myself with the passing allusion I have made to it, I would ask you to revert to the consideration of the wants of the 100,000,000, which, as we have seen, extend to articles of skilled manufacture.

What do they use every day? Take the humblest household first. You will find there metal pots and pans for cooking purposes, kerosene or mineral oil and matches for light, cotton, bone, or metal buttons, pins, hooks and eyes, needles and thread, which enter into the preparation of the family garments of rough native-made fabrics. Then there are tacks and nails, twine and string, a hammer, and other tools in many houses. All these articles, every one of them, is of foreign make.

Peering into another household, a stage or two upraised in the social scale, you find nearly all the articles common to the daily use of a European working man; most of the culinary utensils, lamps, candle and soap, paper, ink, pen, pencil, not a single one of which is made in India. His house is painted with colour or washes of foreign composition, the woodwork of it is varnished with foreign varnish; his clothes are of European manufacture. One degree higher, again, and four-fifths of the articles you find in the domicile of a peon, a petty schoolmaster or a clerk, and on his own and wife and children's persons, are of foreign make. Then come the households of the large middle class, of the successful and comfortable tradesman, the merchant, and the professional man. There, and in a still greater degree, in the mansions of millionaires and the palaces of princes, the predominating proportion of articles is all of foreign manufacture. I try hard to recall to my mind what particular article I should find of Indian workmanship in places like these last, and I do not see many of that description, from the kitchen and stable to the drawing-room and the hall. Some critics who do not fall in with my views, might point to the furniture. That would make a somewhat important exception if I viewed this considerable part of a household as a superficial observer would, but then he does not remember that, save in the simplest and crudest class of furniture, a good proportion of what is known as local furniture is not native-made at all. The springs of a couch or chair, the lining, the buttons, the threads, the hinges of a cupboard or box, the screws, the nails, the locks, the very tools with which these are put together and formed into shape, are all made abroad. So that what remains is the wood and the labour. That even these contribute their due proportion of profit to the native worker, I doubt. English firms and European employers in very many instances control the production of the raw material and the labour, and very appropriately take the profit of it, the native's gain being the bare living wages of his daily toil. To this point I shall revert at a later stage of this paper; for the present it is necessary not to lose sight of the main issue, viz., what proportion of the articles in daily use in a household in India is of native make.

Then, again, let us turn to things of daily consumption. Naturally, and thanks to the system of religion and caste, and the observances and customs which are thereby enjoined on the vast bulk of the people, these things are mainly confined to articles of native growth. Wheat, rice, grains and cereals, vegetables and fruit, milk and its products, which form the staple food of large masses, are all supplied by the labour of the agriculturist and the farmer, and as they do not require skilled manipulation, the foreigner has not invaded this sphere of the country's produce and supply. But the entire English, Parsee, Eurasian, and native Christian communities, a fairly large proportion of the sixty millions of the Mahomedan population, and an appreciable portion of certain Hindoo sects on whom there lies no obligation, on the score of religion and custom, either to abstain from flesh or to avoid eatables not cooked in their own kitchens, are consumers of tinned and preserved provisions, and of wines and spirits. It is difficult to form a correct notion of the aggregate of this class, but placing it at the lowest figure, with due regard to the status in life which renders this consumption almost a necessity, there cannot be less than 3,000,000 into whose daily dietary foreign provisions and condiments and drinks are included. Although this is not a large proportion of the population, still it is sufficient to furnish forth a good market. And when we look at this item not only as regards the amount of money which preserved food carries away from India, but by the light of the waste of raw material, or the diversion into foreign countries of the profit that ought to go into the pockets of the natives, as for instance, in the case of tea, coffee, and condiments, then I contend that the inaptitude of the people of India to betake themselves to industrial pursuits cannot but be regarded as a serious evil, of which the cure can be effected in a great measure, if not wholly, by the inculcation of technical instruction.

We have now before us a picture, in the merest outline, of the demand for manufactured articles which exists in India. The extent and condition of that demand can be but inadequately realised from the few facts I have given above; still, they are sufficient to show that the needs of the people in this direction are as varied as they are extensive. Let us now examine what are the conditions and the system of the production and supply of these articles, what is their range, and what means there are of remedying the defects and deficiencies of that system; how, in short, India can be to-day regarded from an industrial point of view. The popular but somewhat vague notion which prevails on the point, not only outside of that country, but among some of her well-educated classes, is that she is a huge emporium of industries and a competitor formidable to the great industrial centres of Europe.

To my mind this is a great fallacy, and I shall be surprised if you do not come to the same conclusion after you have heard what I have to say. Let us for a moment trace her industrial history from early times.

India, originally, was even more than in the present a purely agricultural country with village communities, including craftsmen who produced everything required for the village and were paid in kind. With reference to the narrow and elementary wants of her inhabitants in the remote past, she might have been considered an industrial country, although not in the sense in which that term is now understood. There are traces of early invaders, and of foreign trading settlers, who utilised cheap labour and the industrious instincts of the population, and started round the coast, and at points on the rivers and the frontiers, industrial centres. But the profits of these industries even from that date did not reach the people. With the advancement of civilisation, and more or less enduring forms of administration which followed, the village communities fell under the dominion of princes, and village craftsmen of a superior kind found their way into great polytechnical cities, and into the courts of chiefs. There are also early records in European history of a large and valuable export trade from India carried on by Greeks, Phœnicians, and Egyptians, followed by Saracen traders, who brought back such fables of India as we find in the history of Sindbad the Sailor, known to every school boy.

In the middle ages the Western nations of Europe took up this trade, and Portugal, Holland, France, and England struggled for supremacy, each wishing to grasp for itself all the profits of the supply of Indian manufactures, such as they were, and of the raw products, then becoming for the first time of commercial value to European manufacturers. In this struggle of nations, fortunately for India, the best has survived, and England, realising her responsibilities to the people whose destinies she has undertaken to direct, has attempted to strengthen her position by fostering native industries to a certain extent. This is apparent in the cotton mills of Bombay, which, although far from being the formidable rivals to Lancashire generally supposed, are supplying the local demand for coarse cloth; in the railway works, which employ a good deal of native labour; and in the cultivation of tea which has been introduced by British enterprise along the great stretch of the Himalayan Hills with such success that in a few years India has become a great rival of China in supplying tea to the markets of the world.

Chief among the industrial pursuits in the India of old times, handed down to a recent date, might be mentioned architecture. Sculpture played a prominent part in the ancient architecture of India. Both the Mahomedans and Hindus gave the greatest development to their industrial energy in this direction in the building of sacred shrines in past times, and in the present age, when buildings of every day utility are being reared up in place of the more gorgeous temples and mausoleums of old, the inherent aptitude of the Indian workman for ornamental carving in wood and stone is freely put into practice in carrying out the designs based on systematic training in Western methods.

Next in point of importance are the manufactures of India. In so thoroughly agricultural a country, and one in which neither the progressive development nor the every day needs of the people had up to the last century attained anything like the standard known to Western nations, the manufactures adapted to the condition of the consumers consisted mainly of coarse stuffs for the bulk of the population, and of fine fabrics of silk, cotton, and wool, and ornamental embroidery for the wealthier class. In this respect the industrial development of India about 200 years ago was equal to that of Europe. But the giant strides which the inventive genius of the West has taken in the last two centuries, while the intellectual power of the East has remained inert, has far out-distanced all competition on the part of India, and European manufactures have to-day not only suppressed, but almost crushed out of existence the handicrafts of India. For instance, the fine muslin industry of Dacca and Benares is now abandoned and almost forgotten; native calico, which derived its name from Calicut on the coast of Malabar, is not known except for the imitation of it which is imported from Europe; and even the ordinary cotton fabrics for the every day use of all but the poorest have given way before the cheaper manufacture of that class sent not only from Lancashire, but from Germany and other continental countries.

Silk weaving, which was at one time a common industry, and in respect of which certain towns, like Surat, were famous throughout the world, first gave way to Chinese silk, and latterly to the French. In respect of this handicraft, it is noteworthy that it was superseded not only by the product of power looms, but was beaten back by the hand-looms of China; and this is a striking instance of that want of technical training which has prevented the native of India from utilising his undoubted intellectual power in maintaining and developing an inherited industry.

Embroidery has to a large extent kept its hold on the Indian craftsman. Shawls and chogas of Cashmere and the Punjaub have hitherto defied competition and even imitation.

Carpets of various materials and descriptions are still a flourishing industry, but it shows signs of surrender to the Brussels manufactured article. There are 22 breweries in India, and the paper, leather, jute, and other factories, give employment to some 200,000 men. Before concluding this necessarily hurried *résumé* of industries, I must refer to the much-talked-of cotton mills of India. There are about 150 mills, two-thirds of these being in Bombay, containing 35,000 looms, and about 4,000,000 spindles, employing about 150,000 hands. I calculate that at the very outside, the number of people engaged in actual industrial pursuits cannot exceed 3,000,000. But the very large proportion of this comparatively small number of the population of the country must be classed as mere labourers, for they work at a daily wage, and have no share in the actual profits of the industries, nor are the industries themselves, except in the manufacture of cotton, and in the tea and coffee plantations, very lucrative.

I am fully cognisant of, and gratefully acknowledge the rapid growth of India as a commercial country under the stimulus afforded to its trade and industries by the protection and peace which has been guaranteed it by the British rule. Its export trade, in pre-British times, did not exceed £1,000,000 sterling in value; to-day its value s 70 fold. But the great bulk of it consists of raw produce. This increase in the quantities and value of these exports is, however, to a great extent responsible for the notion I have alluded to above, of India being a huge manufacturing and industrial emporium. But, when it is remembered that most of the articles that form the export trade leave the country devoid of any native skilled manipulation, they ought to cease to mislead one into the belief that the industrial capacity of India is at all commensurate with her natural wealth of produce, or that the value of her exports of raw material can be at all an index of her inherent capacity for increased industrial production, if scientifically and technically trained, as is too often mistakenly supposed to be the case.

I shall now briefly enumerate some of the chief varieties of raw material which are produced abundantly in the country, of the class that would admit of manipulation. They are:—Coffee, coir, cotton, drugs, dyes, fibres, grain and pulse, gums and resins, hemp, hides and skins, horns, ivory, jute, lac, precious stones, seeds, silk, spices, sugar-cane, tobacco, tea, timber, and wool.

This is by no means a complete list, but it contains a few items which eminently serve my purpose of showing how far—owing to want of ordinary enterprise and the almost entire absence of skilled labour of the most common sort, both of which would result from technical instruction,—India fails to derive the benefit of the rich stores nature has bestowed upon her with a lavish hand. Let us take for example, the item of hides and skins. In 1894-5 India exported Rx 2,179,576 worth of these articles. She imported in the same year prepared leather and leather goods, of the value of Rx 178,597, excluding boots and shoes, the value of which would increase this figure largely. Of raw wool again, the export in the same year amounted in value to Rx 2,016,086; the imports of the same material manufactured being worth Rx 1,541,639. Take seeds. The export of this commodity was valued at Rx. 14,206,042 in the same year, in the course of which the imports of oil, which could have been pressed from the seeds, amounted in value to Rx. 2,122,999. Sugar in a rough form, which left India in that year, was valued at Rx. 1,230,903; the import of the same article, refined, amounted to Rx. 2,875,297. These figures of exports and imports, which can be quoted in respect of every article of the raw produce of India which admits of skilled labour, tell the dismal tale of the drain, from preventible causes, of her natural resources to make the wealth of other countries. The wool and skins, the hides and molasses, and nearly all such articles which are packed away from India, year after year—to be imported again after undergoing manipulation by foreign operatives—would, with the application of a little skilled labour on the spot, offer to millions of her poorest inhabitants the means of subsistence. It would save her, besides, all that large amount of money which is represented by freight, by office and middle-men's charges, and by the difference of exchange, which all goes out of her pocket by the time these articles travel back to her markets and shops in a refined form, or in the shape of articles prepared abroad ready for use by her people. Instead of her keeping as much of this raw material at home as she requires for the manufacture of such articles, and sending out the surplus, either ready manufactured for sale abroad, or at as late a stage of preparation as mere ordinary skilled workmanship would admit of, she chucks it away in bulk, and thus furnishes the means of livelihood to millions of foreigners, while her own children are famishing at home.

Nor is this the case in respect of such articles only as require for their manufacture any particular skill or aptitude which is as yet unknown to them. Tea, coffee, and tobacco, for instance, do not require any very intricate operation before they are ready for consumption. Indeed all the labour they require is exclusively put upon them to-day by the Indian labourer and workman. And yet it is not the native of India that takes the profit on them. It is the European planter and the tobacco and cigar maker, who is from his boyhood apprenticed in those lines, and brings to his work the knowledge and enterprise which are the natural outcome of his training, who pockets the large surplus of gains after the Indian has had his hire. Go through the list of tea and coffee plantations, of tobacco factories, of tanneries, iron and brass foundries, and breweries, oil and flour and bone-crushing factories, woollen and silk mills, and you will find that the proprietor or master or employer, who of course takes all the remainder of the income after the workmen and establishments are paid in a large number of them, is not the native of India. This little enumeration engrosses nearly all of what are called "large industries," and alas! how mean and insignificant, how utterly microscopic, are the variety and extent of them compared to the huge population of the country and in relation to the quantity of articles they consume, save in the one single item of tea. If any one is tempted to challenge the truth of these assertions by pointing to cotton factories as hives of industry which are controlled by natives, the profit of which goes to the people of India, and which are extensive enough to supply most of the country's demand for cotton fabrics, my retort would be, that the very success of that one industry, granting all that is claimed,—although even here the whole profit does not go to India—proves the truth of all my deductions in respect of the others. If the natives are able to command that industry, if they can raise capital, produce skilled workmen, and conduct its affairs so as to make it a source of profit to the country, and that in spite of their inability to make a single object in use in the "plant," there is no reason whatsoever why they could not or should not do the same in the case of all the other industries I have named above, and many more untried ones, for which their own wants afford a wide scope. All that they require for that purpose is enterprise and skill. Without skill they cannot have the necessary impulse of venture, and to attain skill they must have the help and guidance of technical instruction.

This brings us to the subject proper of this paper. It might seem strange that I should have dwelt at such length on what is practically a preamble to the thesis, delaying so far the actual treatment thereof. But there has been so little done hitherto in the direction of technical instruction in India, that I have very scant materials to lay before you. On the other hand the omission of that teaching has already resulted in such an amount of mischief and misery to the land, has so retarded her development, nay, so grievously stunted her resources, so impoverished her people, and so dwarfed all those energies that go to make a country prosperous and powerful, that I thought I would best make out a case for a speedy and vigorous effort in future to repair that serious omission in the past by delineating the evils which it has produced and is ever increasingly producing in the present.

Except for a very few desultory institutions started within the last decade, there have been no efforts made for the training of the people of India in industrial pursuits based upon scientific principles. Schools of art with this purpose partially in view, were started some years back in a few chief towns, but their objects were in the main to preserve all that was left of art traditions in India, to save her fine arts from being contaminated by the thoughtless and vile imitations of European styles and models, and, if possible, to develop the native faculty and ideas of ornamental or decorative art. It is outside the purpose of this paper nor would I be competent to judge of how far they have succeeded in reviving the natural instincts of the people of India. But if they have succeeded in any degree in influencing art industries, they have had no perceptible effect upon the manufactures or the profitable development of the material resources of the country.

The workshops of railways and of some of the private factories, and laboratories in a few colleges, used to be the only openings for the Indian youth to obtain a rudimentary knowledge of mechanics and chemistry, until about ten years ago, when for the first time efforts were made in Madras and Bombay to start technical institutions. The scheme of the former has mostly remained on paper, and for some reason Madras has been unable to begin the actual work of instruction. The Bombay project was lucky in having for its guide an educationalist of varied experience and Continental reputation in the person of the Governor of the Presidency. Lord Reay, who gave it a sound working committee of business men, and a secretary, who was himself trained in some of the best English industrial centres as a mechanical engineer. In this gentleman, the Honourable N. N. Wadia, C.I.E., was combined with great technical knowledge, a large acquaintance with the wants of the country and the characteristics of her people. Those qualities enabled him, with the help of efficient teachers obtained from Europe, to organise a system of instruction in such departments of industry as were most in vogue in Bombay, the result of which has amply proved the utility of the institution even in the few years it has been in existence. Lord Harris, who succeeded Lord Reay, took a lively interest in the growth of the institute; the pupils who studied in and were diplomaed by it, obtained lucrative situations in the local mills and factories, and altogether from a combination of various favourable causes the Victoria Technical Institute has been enabled to plant its foot firmly on the soil of Bombay, I had the privilege of visiting it last January and I rejoiced to find some of my pet beliefs with regard to the aptitude of the Indian youth to work with as deft a hand and as artistic a faculty as the skilled European artisan—given the same training and the same opportunities—realised, especially when I saw in a newly-created department sign-boards and household utensils in enamelled metal prepared by the students. Hardware and cutlery imports in India in 1895-6 were valued at Rx. 1,422,533, and roughly estimating the price of the description of articles in hardware which I saw manufactured in the Victoria Technical Institute at considerably lower than a third of that amount, here is an illustration of how Rx. 400,000 might at once be kept every year in India, which has hitherto gone out of the country on just one common item of import. Many other such results of the efficiency of the teachers and the diligence and capacity of the students were shown to me in this excellent institution, which I cannot attempt to describe in detail,—but I came away from it firmer in my conviction that technical instruction was the only means by which India could be saved from her poverty, helplessness and degradation, and sad with the thought that such a feasible mode of securing the country's welfare should have been so long delayed by her Government, and so utterly neglected by her people,—for I am told that there is even now only one establishment of its kind in all the continent, and that with this exception, the only opening for the coming generation of men to train itself in industrial pursuits is the narrow door by which occasionally a youth here and there might get by favour into a railway or private workshop to obtain a smattering of mechanical knowledge.

My history of the technical industrial education carried on at present in India began with the last paragraph and must end with it. Although I cannot pretend to personal acquaintance with all or most of her provinces, I do not think the existence of any properly organised institution elsewhere, similar to the one in Bombay, would have been unknown to me. Small classes for carpentery, joinery, &c., there might be in a few districts, but none of them so equipped, or aided by public or private enterprise, as to be effective of much good. The caste organisation in its ancient integrity which aimed at continuing the handicraft peculiar to it has disappeared. Well-organised apprenticeship to industries is unknown. Cheap continental ware of all sorts is fast driving out whatever is heretofore left to the native operative to perform. And, worse than all, a vague and vain system of so-called liberal education on a purely literary organisation, is implanting in the minds of her youth a dislike, and even an aversion, to the pursuit of the trades and industries of their fathers, which are fast giving way before professions in which there are already more practitioners than remunerative work or clients.

Of all these and other causes which have led to this arrest and decay of industries in India, and to the entire absence of any new developments, the last named is the most potent and operates both directly and indirectly. The system of education which has now taken root in the soil is every year growing wider in the anti-industrial direction which it unfortunately took from the first. The son of the merchant, the tradesman, the artisan, the shopkeeper, who was at the inauguration of that system drawn with some trouble and indiscriminately within its sphere, stayed in it too long to get back contentedly to his father's avocation with a firm resolve to foster and develop it by those means which his education was meant to furnish him with. The first opening offered into, and the success well deserved in some, and easily attained owing to want of competition in many cases, which attended those who entered the professions of law or medicine, or the offices of Government, fixed unreservedly to that system a purpose which is not the legitimate goal of popular education. The desk and the ledger, the workman's apron and turned-up sleeves, the long hours of toil and the early years of doubt and anxiety about profits, which are the essential elements of success in all industrial pursuits, have naturally less attraction to a youth launching upon life than the lawyer's briefs and doctor's prescriptions, or the settled hours and fixed income of work in Government offices. In the case of many an Indian youth, his father, a good manly fellow who, by dint of industry, honest though untrained, and humble, has laid by a few hundred or thousand rupees, (but to him education on our system is an exotic) rejoices to see his son spout English verse and write elegant essays, and is not sorry at the thought that he will easily earn as much pay from his clients, or the public treasury in a month, as it cost him at that age a year's hard industry to produce. This, at first sight, is no doubt a highly pleasant prospect. But the father is too ignorant and the son too inexperienced to take into calculation the growing social and domestic wants of the coming time, the loss both to his country and to his house of the old family trade or industry, which, if properly matured and developed by the light of new knowledge, would unfailingly become a source of personal and national wealth; and the direct drain both on the community and on the individual from the replacement by foreign labour of manufactures which must perforce take the place of the produce of the lost home-industry is a problem which would strike the imagination of neither father nor son. Thus, not only are there no new industrial avenues opened, but the old ones are being fast closed from this misdirected use and misunderstood purpose of the education as imparted at present to the youth of India, and from the unhappy character of that education which is mainly literary and in no wise technical. Instance after instance of old industrial communities being thrown out of work, scores of industries being dead or dying, and not a single new one of any dimension taking their place, might be gathered by a critical observer. If some of the old trades and industrial pursuits still exist, it is a remarkable fact that their term of life is limited to the period up to which the castes or communities whose peculiar avocation they are, will resist the attraction of that system of education of which I have just spoken. The loss of industrial arts and labour in India proceeds almost in exact ratio to the progress of this spurious education. Take, for example, the Parsee community, which is known to have made the start in the race after Western education. Their inherent pluck and aptitude for work, among other qualities, which were first brought out conspicuously under British rule, had in the last generation made them the masters of many art industries and lucrative trades. They became first-rate shipwrights, cabinet-makers, workers in carved sandalwood and inlaid ivory, owners of silk-weaving establishments, gardeners, druggists, bakers, confectioners, victuallers. All these industries in which education, if properly supplemented by technical training, would have enabled the new generation of them to develop and become large and wealthy employers of labour, are lost or nearly all lost to them now. The sons of former merchants and dockmasters, of furniture makers and ship-chandlers, are most of them glutting the medical and legal professions or content to be petty clerks and school teachers. The same might be said of other communities, but it would be too long to multiply instances here.

I shall just briefly allude to the contention which I have heard advanced in refutation of the views here expounded as to the anti-industrial effects of the education which is at present in vogue in India. It is argued that the same abandonment of old pursuits and tendency to elegant and easy life result from the mode of instruction pursued in England and other thriving countries of the West, and that therefore it is a fallacy to assume that it has an adverse effect, in the long run, upon national industry, or upon national prosperity. This contention is true to a certain extent, and in a certain sense. The evil effects of purely scholastic instruction for the masses are already realised in the countries of Europe, and strenuous efforts made to arrest them; on the other hand, their vast wealth, their expanding dominion and commerce, their colossal manufactories, the progressive inventions of their scientific men, the inexhaustible energy and enterprise of their tradesmen and workmen, and a hundred other forces, entirely unknown or unfelt in India, more than counterbalance the mischief. If an art or industry is lost in a European country, a new one not infrequently takes its place, and the existing ones are ever developing. So that the analogy of the optimist with regard to India does not hold good, where every industry that is lost is at once replaced in its products by foreign goods, and is by so much a permament loss to the means of subsistence of the working masses, and an added burden on those classes which are every day trained in increasing numbers to use and, therefore, compelled to buy such goods.

There are some people, again, who assert that this loss is made up by the opening of new channels of industry as is evidenced by the increasing activity of bazaars. But even if depôts are every year opened out, and more workshops are seen in large towns, it is a mistake to suppose that they compensate for the indigenous industrial pursuits that are being lost one after another. These depôts are merely storehouses of foreign wares, and these workshops are the very places in which the practical, but scientifically and techinally untrained, native workman is employed to put together or combine in a whole the component parts prepared in European factories, of the article which the consumer in India requires for immediate use. This process is mistakenly supposed to be a new industry. It is nothing of the kind. Take the boot-making business in several parts of India. It locally turns out a large number of boots which the educated native, preferring to be shod in the European style, buys from a so-called native workshop, at once satisfiying his slender means and patriotic impulse. In doing so he thinks he buys a native-made article, the whole profit of which would remain in the country if a foreign Government did not drain part of it away for administrative purposes. All the same, he is himself paying on that very article to foreign manufacturers an immense profit, for the prepared tops, the soles, the buttons, the eyes and the lace, the elastic, the thread, the tacks, and the very needles and hammers and other tools with which they are put together, all come from abroad. What he does pay to his own country on that boot is the mere labour wage of putting these things together, and possibly a bare margin of profit to the native wholesale merchant who imported those several component parts. The mistake in this case, which the educated buyer unknowingly flounders in, and the unlucrative return which accrues to the scientifically untrained workman for his diligent toil, year in and year out, are the results of the absence of that technical education which is the only means by which a single pair of boots can eventually, if ever, be really made in India. When that happy era arrives, I think the educated native of to-day, if living then, would find that after all it was not the administrative charges of a foreign Government that made his country so deplorably poor that it could not battle with the first ravages of a famine at the close of the 19th century, but that its helplessness came from within he country itself, and that he himself was the largest contributor to his country's impoverishment in that he resisted the replacement of a meretricious and hollow education by a sound course of technical instruction.

Again, it is often urged that the want of metal and fuel in India are an insurmountable bar to manufacturing industry. That it is a disadvantage I fully grant, but the cheap labour of India is a powerful compensation. The industries that are flourishing in India proves this to the hilt. These are the cotton and other mills, the foundries, the breweries, the cigar factories. That all these in the initial stage were, and most of them even now are, owned by Europeans, unmistakeably points to the fact that in whatever industry European capital and energy and skill have been spent, in that particular industry at least this supposed invincible defect has been overcome. As a further illustration of this argument I shall point to the fact that even the products from such material as can best grow from the nature of the Indian soil, and by such manipulation as her people are best adapted, whether from long usage or from economic conditions, to exercise, are being turned to profit by the foreign trader, because the native, for want of technical training, and of the confidence and other business qualities which such training begets, is unable to keep the industries that produce them to himself. Tea, coffee, indigo, and certain drugs, are evident examples. Fish, and fruit, such as plantains and mangoes, which are destined to become before long—but not until European capital and enterprise shall turn in that direction—a large export trade, are to-day practically wasted in large quantities because from one end of India to the other there is not a native trained in the rudimentary art of canning edibles. This serves to show that the main bar to, say, some at present small Indian fruit-seller, or fishmonger, becoming the affluent master of a great export trade in fish or fruit, is the want of technical knowledge to preserve, and can, or bottle, his fruit or fish. That, however, which directly illustrates the contention that even a product of exclusive native growth and make is largely monopolised by foreigners for the purposes of profitable export is the large European trade that has come into existence in recent years in such articles as chutnees and curries, pickles, and other condiments. The native makes it wholly and solely in the old fashion. If there are new varieties they are made to the order of European masters or agents. They are sent here in bulk and in crude shapes at little over cost price, which pays the labourer's wage and scarcely more than the subsistence allowance of his fellow-countryman who employs him in a primitive workshop devoid of any modern appliances or apparatus. By the time they are placed on the table of the English household, they are distributed by the English importer in bottles with elegant designs, one of which I picked up last Easter in an ordinary grocery store in Ramsgate. For evident reasons I omit the name and the address of the company selling it, but that is not necessary to the elucidation of the fact that whereas an article of exclusive Indian make yielded to the native manufacturer a bare profit over the cost price, to the more enterprising and skilled English victualler, who from his training is able to detect in it an attractive article of popular consumption if properly prepared for the shop window, it has become a source of great wealth. I could multiply such instances without limit to prove that the want of technical instruction is at the root, not only of the loss of most of India's industries, but of much of that poverty and helplessness under which she labours.

There is in the country the raw produce, and also the labour, necessary for industrial pursuits. The excellent catalogue of the economic products of the Bombay presidency, published by that great friend and well-wisher of India, Sir George Birdwood, proved as far back as 35 years ago, of that part of India what is true of many other parts, that her raw material wealth is practically unbounded in quantity and rich in variety. Other larger works in the same direction, published at later dates, have brought within the reach of students of Indian economic products the widest and fullest knowledge. The artistic and scientific faculties, too, of the native of India are of a high order, which have evoked the praise of many competent judges and observers. They have always excelled not only in hereditary and indigenous arts, but whenever they have turned their attention to it they have in many cases shown superiority of skill in arts imported from the West, and an aptitude for converting them into profitable industries. To give just one case I would mention the great photographic business reared up in India by the Raja Deen Dayal. This gentleman's diligent and trained pursuit of photography had been for years known in several parts of India, but I was not prepared to find that great perfection of the art which he had attained until I saw last January samples of his work in his newly opened depôt in Bombay. His portraits and pictures, in style and finish, and in other artistic merits are equal to the best that one could find in any European photographic establishment. But what struck me even more than this artistic excellence of his work was the elegantly comfortable, yet business-like, surroundings of his studio, and his own modest and intellectual conversation on many economic and industrial topics, all tending to show how an educated native of India if brought under the influence of technical instruction is thorougly capable of developing any art or scientific calling into a profitable and pleasurable industry for himself and his countrymen.

Now this paper has lengthened out considerably beyoud what I intended when I first undertook to write it, and still it has but touched the fringe of the important subject it deals with. My treatment of it has been hurried and crude, but still I have, I hope, been able to show you, by a few figures, arguments, and illustrations, that on the one hand, there is scarcely any technical instruction imparted in India, and that, on the other, that is India's greatest need from more points of view than the economic. All-important as this point is, I submit that if, as I firmly believe, a system of technical instruction widely diffused throughout the country were to lead to a higher appreciation of Britain's domination over India than is at present to be found, that of itself ought to prove not the least of those impulses under which her administrators are bound, without further delay, to do all that they can to furnish her with the means of developing the vast natural resources of the country and the industrial and artistic faculties of her literally teeming millions, than whom no more industrious, patient, provident, tractable, and loyal people anywhere exist within the wide range of the British Empire.

Mr. A. PEDLER, F.R.S. (Calcutta), said, in dealing with technical education in India, they must remember that the whole of the educational system, treated from a Western point of view, was only of comparatively recent growth. Undoubtedly, education had suffered in India in the first instance from being designed solely by gentlemen of literary tastes, and it was only about 25 years ago that a want was felt and expressed for something like scientific instruction. During the last 25 years science had been introduced into certain schools and colleges, though not into the primary education; nothing had been done in that way. In the other Section, with reference to the general discussion about technical education, it had been strongly emphasised that we could not have anything like success in technical education unless we had a fairly good general education to start with. The first thing theretore they had to do in India was to make the education more generally scientific before they could attempt to add anything like general technical instruction to it. In the attempts which had been made to introduce science, especially practical science, into Indian education, many difficulties had arisen. When he went out to India, 24 years ago, he started a chemical laboratory, and at first he found the practical students almost refused to do anything more than perform the experiments; they objected to do the washing up of the apparatus, &c. When they had done their experiments they wanted the servants to come and wash the test-tubes and the flasks, and he had to put his foot down firmly against that kind of thing. Things were now better, and the taste for practical work had very largely increased. They had tried over and over again to introduce science into the lower stages of education, but at present they were met with a certain amount of opposition; and one great reason why the opposition was put forward was that the teaching of science was more expensive than the teaching of literature. But as the general welfare of the people increased, undoubtedly there would be a much better opportunity of introducing scientific training into the schools. Things were rather working in that direction now. When he first went out to India, a B.A. of the University with which he was closely connected used to expect at least 50 or 60 rupees a month—about £4. Now you could get a B.A. to work in a Government office in Calcutta for about 20 rupees a month; that showed that the value of such labour had fallen to about one-third. On the other hand, he knew of technical schools in Bengal where an ordinary carpenter or blacksmith instructor was getting 40 or 50 rupees a month. People were therefore beginning to find that the purely literary side of education did not pay, and when a country began to find that, it was certainly a beginning of the end. Mr. Bhownaggree had given them a rather pessimistic account of the manufacturing industry that was to be found India. He could only speak from actual experience of the province of Bengal, and he could assure Mr. Bhownaggree that within the last 25 years there had been a wonderful change. When he first went to Calcutta he could have counted the whole of the large manufactories on the fingers of one hand. At the present time mills were springing up almost every day, and it was now said to be rather difficult to obtain land on which to erect factories. Many of them were worked with European capital and managers; but within the last four or five years there had been indications that the native gentlemen were taking note of what was going on, and they were starting factories for themselves. Within the last few years factories and industries had been started entirely with native capital, and worked by native managers in several directions, such as light railways, cotton mills, metal industries, tea gardens, match-making, &c. There were also, he believed, many other factories now in various parts of India which were entirely owned by native gentlemen. In addition there were small factories or workshops where one could get such things as knives and scissors, &c., entirely of native manufacture. He possessed a chemical balance, the manufacture of which required a certain amount of delicacy of workmanship, made entirely by native workmen; and the Government had erected a factory for the manufacture of telegraphic instruments, showing that very delicate apparatus could also be prepared in India. Also within the last five years technical schools had been started in head-quarter towns of several districts of Bengal, and some of them were really doing very good work—such as blacksmith's work, carpentering, repair of bicycles, carriages, guns, &c., and so on. He therefore did not look upon the state of India in quite so pessimistic an attitude as did Mr. Bhownaggree.

Professor CHATTERTON felt sure they would all agree that the papers they had listened to presented them with a very lucid and interesting account of the general conditions prevailing in India with regard to its material and social conditions; but there were one or two points raised by Mr. Bhownaggree upon which he thought some word of explanation might be offered. Mr. Bhownaggree had referred to the fact that India exported enormous quantities of wheat and imported Huntley and Palmer's buscuits; that it exported a large quantity of wool, and imported woollen manufactures. These were undoubted facts, but if they looked at the conditions of modern manufacture they would find that it required a great deal more than technical education to remedy these matters. Take the case of Indian wheats. Indian wheat was a peculiarly hard kind of wheat, which was suitable for making a certain kind of flour. The best biscuits were not made from any one kind of wheat, but were manufactured from wheats grown in all parts of the world, which were brought to Great Britain and mixed and ground in modern roller mills. If they attempted to make buscuits from purely Indian wheat they would be very inferior to what are produced both in London and Reading. Again, in connection with the woollen manufactures. India wanted a great variety of manufactured woollen goods, and if any attempt were made to start the necessary mills for producing these goods it could only be done on so large a scale that they would produce more than was wanted, and the industrial conditions were such that it was only possible to send the wool to great manufacturing centres, such as existed in Yorkshire, where the wool could be manufactured in different mills by different firms into the various articles required for the use of India. Mr. Bhownaggree said in his paper, "I contend that the inaptitude of people of India to betake themselves to industrial pursuits cannot but be regarded as a serious evil, of which the cure can be effected in a great measure, if not wholly, by the inculcation of technical instruction." He thought that Mr. Bhownaggree was making too much of technical instruction; he wanted to change the character and inherent traits of the whole people by means of technical instruction. That was a little more than could be expected. Mr. Bhownaggree's general contention was that technical education had made no progress whatever in India. He (the speaker) thought that the remarks which had fallen from Professor Pedler would lead them to see that at any rate in Bengal something had been done. He thought he could also say that in Madras they had not been altogether backward in the matter of technical education. To give them some ideas of the difficulties under which they laboured in Madras, in connection with technical instruction, he had taken out some figures for the two years, 1893-4, regarding the expenditure on education in the whole of the Madras presidency. The population, roughly speaking, was about 37,000,000, and the total expenditure on education from every source, including fees, in the Madras presidency in the years 1893-4 was 61 lacs of rupees, which was something under £400,000. A very simple calculation would show that the total amount available for expenditure on the whole of the education of the country amounted to less than one-tenth of a pie per head per day, which was equal to about three-pence per annum for each individual in the presidency. What was the result of that? The whole of the subordinate, and not a small number of the higher, appointments in the service of the Madras presidency were filled by natives who had been educated under that system. It could thus be seen that a very considerable amount of work had been done for the expenditure of a comparatively small sum of money. The idea seemed to prevail in Mr. Bhownaggree's paper that technical education was quite a recent thing in India, whereas it was really much older than in many other countries. The institution with which he had the honour of being connected was founded 105 years ago, and was the first educational institution in India. It began owing to the necessity of obtaining surveyors for certain survey works, and from the small training school which was then established by degrees had grown the present College of Engineering, where they had something over 200 students, who received the necessary training for all the requirements of engineering work. True, the greater part of the training was for students who subsequently found employment in the Public Works Department, but not a small number of them passed out as industrial teachers and were employed in the local industrial schools in the presidency. Besides the Engineering College of Madras there was a Law College, a Medical College, and a College of Agriculture, all of which were really technical colleges, and although these three colleges did not fall within the scope of the remarks which had been made, yet they were doing a very good and useful work. With regard to the technical instruction of artisans, a great deal had been done in Madras under the initiative of missionary enterprise; a considerable number of industrial schools had been started, and those schools were undoubtedly doing a very useful work, mainly in introducing European tools and European methods of working, and in diffusing all over the country the technical knowledge which was only to be found in certain sections of it. There was no doubt whatever that the best of the native artisans were extremely skilful and dexterous men, but they were a very small and limited number. For instance, in Bellary they had extremely good and skilful blacksmiths, but all over the rest of the country the blacksmiths were miserably poor workmen. In Kumbakonam they had extremely good metal workers, but in other places they were very bad. In Madura they had weavers, and so on with a great variety of industries. What the industrial schools were doing was to level up the general standard of excellence throughout the country. The great difficulty they experienced in dealing with these industrial schools was in providing suitable teachers, especially in connection with such industries as carpentering and blacksmiths' work. The method they had adopted lately was one which he should like to allude to in detail as an instance of the way they tried to overcome such difficulties in India, with the limited means at their disposal. In the Engineering College the workshops were very well equipped with tools and machinery, and the instructors, who were employed in teaching the engineering students, were fairly skilled artisans. The college students used the workshops mostly in the early mornings, and during the daytime they were available for other purposes. In the industrial schools there were a large number of boys who were trained for several years at carpentry and blacksmith's work; they took the best of these boys after they had served three or four years in the industrial schools, and brought them up to the Madras College of Engineering, and kept them there for three years and paid them six, seven, and eight rupees a month in each successive year, and during that time they received a training in the higher branches of carpentry, in fitters' work, in blacksmiths' work, and so forth, and at the end of that time they hoped to be able to send them out as technical teachers.

Dr. R. M. Walmsley, while thanking Mr. Bhownaggree for his very able paper on industrial education in India, said he must venture to differ from him when he said that only a tinge of technical education was wanted. In his (the speaker's) opinion a tinge of technical education was of very little value whatever; they wanted a thorough-going system established as soon as possible. The native Indian artisan was capable of technical training and that to a very large extent. He thought one reason why the previous schemes of technical education in India had not borne very great fruit was that the upper and middle classes as a body were not interested in the question. It was quite true that during the term of office of some particular governor of a presidency who was interested in technical education it became fashionable and then the higher class of natives turned their minds in that direction, but it was not for the love of education but simply to please the governor. Another reason was that among the upper and middle classes education was regarded chiefly from the point of view of obtaining a Government appointment. There was one matter on which he should like to caution those who had taken up this question—viz., that of the product of the technical workshops competing with outside labour. He found in one technical college in India that the students in the classes were not only producing work in competition with outside labour, but were even repairing carriages and doing all kinds of odd jobs for outside customers. Fortunately for the college authorities, there was no trades union at hand to say anything about it. In conclusion, he wished to express his personal thanks for a very good paper.

Sir Owen Tudor Burne said he had been connected with India for a long time, and agreed generally with both papers. He thought they were valuable contributions to the Congress, and if they had the effect of leading the educational authorities of India to look more to the technical and practical instruction of the people than to mere intellectual education, they would not have been written in vain. His own experience in India and elsewhere had taught him that Governments which put money on education without sufficient regard to the practical and technical side of it, as fitting an individual for some useful profession or trade in after life, only too often trained men to be political rebels and seditious newspaper writers, unfit for any real work, untrained in practical questions, and unable to obtain Government or other employment. He hoped that the papers just read would receive attention from those interested in educational questions in India.

Miscellaneous.

PETROLEUM IN JAPAN.

Petroleum sinking is one of the industries that has lately effected a signal success in Japan. In 1893, the total of the petroleum sections leased was 199, with a total output of 3,320,707 gallons. Of these, fourteen sections yielded above 400,000 gallons per annum, with an aggregate output of 2,829,181 gallons. In 1889, the total yield was 2,218,679 gallons, and therefore this yield was increased above 50 per cent. during the short period of four or five years. Mr. Robert P. Porter, late Superintendent of the Eleventh Census of the United States, who has lately been engaged in an investigation of the industries of Japan, says that the principal petroleum districts of that country are Hokkaido, Ugo, Echigo, Shimane, and Totomi, and of these Echigo stands foremost, its yield amounting to 90 per cent. of the total output of the whole country. Next to Echigo, but far below it, comes Totomi, with its yearly output of about 120,000 gallons. Hokkaido, Shimane, and Ugo yield less than 40,000 gallons each. Kerosene-yielding localities in the province of Echigo are abundant, numbering over thirty, but of these only three localities are famous, containing about eighty wells. The deepest of these wells is 756 ft. Their daily output exceeds 18,000 gallons. In another important oil locality the American boring process is used, the deepest of some fifty wells reaching 1,800 ft., and the aggregate yield being about 4,000 gallons daily. The kerosene produced in Hokkaido, Ugo, and Shimane is thicker, while that from Echigo varies in density; that of Amase, where the American process is in use, is clear, and the best in quality. The chief reason why the yearly petroleum has lately increased is the discovery of a new well, in 1890, in the vicinity of the town of Hagaoka, Echigo, and the introduction of the American method at Amase. It is confidently believed that as the wells are in general less than 600 ft. deep, there being only one or two that reach 1,600 ft., the supply, judging from the experiments as carried on in the western oil-yielding districts, must be quite abundant, and the more extensive introduction of American methods must mark an epoch in the industry.

General Notes.

Madrid Exhibition.—Information has been received from the Foreign-office through the Science and Art Department, of an Exhibition to be held at Madrid. A royal decree by the Queen Regent of Spain has been issued for the holding of an Exhibition of Spanish Industries in the Palace of Industry and Art at Madrid, in the autumn of the present year. The products of modern industry will be received from Barcelona, where they have been collected by the Society for the Protection of National Labour, and from the other provinces of Spain. The Exhibition will be opened on the 20th October next.

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FRIDAY, AUGUST 20, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1898.

The dates fixed for the Society's Examinations in 1898 are Monday, March 21st, Tuesday, 22nd, Wednesday, 23rd, and Thursday, 24th.

The Programme of Examinations is now ready, Copies of the Programme, with full details, and an Appendix containing last year's questions and reports by the Examiners, can be had, price 3d., post free, on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, London, W.C.

Proceedings of the Society.

HOWARD LECTURES.

THE MECHANICAL PRODUCTION OF COLD.

By Prof. J. A. Ewing, M.A., F.R.S., M.Inst.C.E.

Lecture II.—Delivered February 4, 1897.

Classification of Machines.

In the first lecture I dealt with the process of refrigeration from the point of view of abstract thermo-dynamics. We have now to consider the development of actual refrigerating machines. We may classify such machines by reference to the particular working substance they employ. A broad distinction may be drawn between machines which use air as their working substance, and those which use a liquid, which is alternately vaporised and liquified during the cycle of operations. Generally speaking, in this second class of machines the liquid which is used is one whose vapour pressure is higher than the pressure of the atmosphere, under the actual conditions of temperature at which the machine works. If we take, for instance, ammonia or sulphurous acid, or carbonic acid, as the liquid which is alternately liquified and vaporised, we find that under the conditions of temperature within which such machines work the pressure of the vapour is higher than the atmospheric pressure. But it is quite possible to use a liquid which can only be vaporised by submitting it to a lower pressure than that of the atmosphere under the given conditions as to temperature. Water is an instance in point. At the temperatures at which refrigerating machines work water can only be vaporised by subjecting it to a much lower pressure than that of the atmosphere. Consequently, when water is the working substance, as it is in certain machines, the whole action is taking place in what is relatively speaking a vacuum. It has to take place in chambers which are maintained at a pressure much below the pressure of the atmosphere, and consequently machines using water as their working substance are frequently spoken of, for this reason, as vacuum machines. This name is applied as a general title to machines in which the vapour pressure is considerably less than the atmospheric pressure throughout the cycle.

Further, when a vaporised liquid is used for working substance we may either adopt simply mechanical compression as the means of restoring the vapour to the liquid state, or we may adopt in place of mechanical compression a chemical action between the vapour and some other substance which has an affinity for it. This gives rise to a group of machines which we may classify as absorption machines, where a quasi-chemical action or species at least of solution goes on as a substitute for the mechanical compression used in the other vapour machines. In absorption machines there is usually a direct application of heat instead of mechanical power, and this forms another distinction between such machines and those of the compression type.

Then we may classify machines of the vapour-compression type according to the particular vapour which they employ, as ammonia, carbonic acid, sulphurous acid, or ether machines.

We may also divide air-machines into two groups, in one of which the same volume of air is made to pass again and again through a cycle of operations without leaving the machine. In this group of machines the air is confined in vessels which allow it to be used throughout its working cycle of operations at a pressure higher than that of the atmosphere. Such machines are called closed cycle machines to distinguish them from the ordinary refrigerating machines employing air, in which we have the air discharged from the machine at atmospheric pressure, and then taken back again to the machine at atmospheric pressure.

DEVELOPMENT OF AIR MACHINES: HISTORICAL SKETCH.

Vapour compression machines—that is machines which employ the alternate condensation and evaporation of a vapour, under two pressures and therefore at two temperatures—form now-a-days by far the most important class of refrigerating machines. We shall discuss them later; but first I have to speak of machines which employ air as the working substance; such machines fill a large place in the history of the development of mechanical refrigeration, and they are still doing useful work. The first form of air-refrigerating machine of which there is any notice was one invented by Dr. Gorrie at New Orleans about 1845. The earliest published account of it which I have been able to find dates from 1849. It was patented about that time in England, and a machine was constructed with the intention of using it to make ice. Sir William Siemens was asked to examine this machine professionally because it had failed to do what was expected of it, and in 1857 he wrote a report in which he criticised the machine point by point, indicating the various reasons why its duty was less than had been anticipated, and showing what were the several respects in which it might be improved. This report was afterwards published in the Proceedings of the Civil Engineers as a contribution to a discussion on "Refrigerating Machinery."* Dr. Gorrie's machine had a compression cylinder in which the air was compressed, and from which it passed into a chamber which was kept cool by surrounding water. This chamber or receiver was maintained at a pressure of about 15 lbs. per square inch. The air was partly cooled during compression by the injection of water, so that what passed on to the receiver was really air and water together. The air was further cooled in the receiver by the application of cold water outside, and then it passed on to another cylinder, in which it was allowed to expand down to something like atmospheric pressure. While it was expanding it was mixed with a certain quantity of brine, which was injected into the expansion cylinder. By being expanded the air became much cooled and its low temperature was communicated by direct contact to the brine which was mixed with it in the expansion cylinder. The air leaving the expansion cylinder was allowed to escape to the atmosphere, while the brine, which had been cooled to about 20° Fahr., was conveyed into a tank, and was usefully applied to ice-making or other refrigerating purposes.

Siemens pointed out that by no means the whole of the cold which was produced in this machine was usefully applied. The air was allowed to escape to the atmosphere at the low temperature which it had reached in expansion, and the only part of the cold which could be said to be usefully applied was that part which was communicated to the brine during expansion. One of Siemens' suggestions was that the cold air, instead of being simply allowed to escape to the atmosphere, should be made to give up its heat to the atmospheric air which the engine was taking in for its next stroke, and he proposed what became known as an interchanger for this purpose. According to this proposal, the cold air before being liberated should pass through a series of pipes, outside of which should pass the air which was coming to the compression cylinder from the atmosphere; in this way most of the cold would be saved which was being allowed to go to waste through the direct discharge of the chilled air into the atmosphere. This interchanger of Siemens' is the earliest example we have of what may be called the regenerative principle as applied to refrigerating machines. If we had time to go into the history of the subject in detail, we should find substantially the same idea cropping up at various dates, and being applied in various ways. We find it in ammonia absorption machines, and we find it also taking a very practical form in some of the latest developments of the art of producing cold, which I shall have to refer to in my last lecture.

Another point to which Siemens drew attention was this. In Dr. Gorrie's machine there was placed between the chamber containing the compressed air and the expansion cylinder a regulating valve, which was only partially open, so that the air lost a good deal of its pressure as it passed from the chamber into the expansion cylinder. Siemens pointed out that the introduction of this throttle-valve was entirely wrong from the thermo-dynamic point of view, and that it resulted in much loss of refrigerating effect. When air passes through a throttle valve it scarcely falls in temperature at all, but the reduction of pressure puts it in a worse position for being chilled by expansion in the cylinder since there is now a smaller range of pressure through which it can expand. A third point which the report of Siemens dealt with in detail was the influence of the moisture contained in the air on the efficiency of the apparatus. The whole report is a document of great interest to any student of the subject as being the earliest criticism of a real refrigerating machine from the point of view of the mechanical theory of heat.

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* Min. Proc., Inst. C.E., vol. lxviii., 1882, p. 179.

There was, however, a paper some years earlier than this by Lord Kelvin, which ought to be referred to in any history of the subject, however brief.* In 1852 the subject was engaging the attention of Kelvin, and also of another great founder of applied thermodynamics, Rankine.

Kelvin describes in language which is almost precise enough for a patent specification a machine substantially the same as that which afterwards became a practical success in the hands of Coleman and other inventors. Indeed, Mr. Coleman, in his description of his well-known machine, admits frankly that he owes the inspiration of it to Lord Kelvin.

KIRK'S REGENERATIVE AIR MACHINE.

But before we pass on to see what fruit came from this important paper; we have to deal with another type of air-machine, which was carried to a practical issue by Dr. Alexander Kirk in the year 1862. Kirk's air machine was one in which a confined mass of air was passed through the cycle operations at a pressure always considerably higher than the pressure of the atmosphere. It was, therefore, what I have classified as a closed cycle air machine. Students of heat-engine theory will recognise it as simply a Stirling air-engine working reversed; that is to say, working as a heat-pump, instead of working as a heat-engine. Kirk began by making a small model, a diagram of which is given in Fig. 13. A B C D was a tin-plate cylinder five inches in diameter, inside of which there was a peculiar double conical plunger, N O N, which fitted only very loosely, and could be moved easily up or down, having a stroke of $1\frac{1}{4}$ inch. The part N N, which goes all round, was simply a non-conducting mass. In the middle at O there was a regenerator which consisted of a number of plates of metallic gauze, through which, when the plunger moved, the air would pass alternately, giving up heat as it passed in one direction, and taking the heat back as it passed in the other direction. When the plunger was pushed down to its lowest point, there was scarcely any space left below it for air, consequently the air had to pass up through the regenerator into the annular space above. The substance which was to be cooled was put into the cup, E, and a non-conducting cover was fitted over it. A pipe, L, led from the bottom of the space below the plunger, and communicated with a compressing syringe or an air-pump without valves. When the piston of this syringe was pressed home it compressed the air in A B C D to about double its original pressure, and when it was drawn out again it allowed that air to expand, and recover its original pressure. While the air was being compressed, the plunger N O N was put up to the top, and the consequence was that the compressed air was compressed in the annular space underneath the plunger. A circulation of cold water was maintained in the conical chamber, F, so that the heat generated by compression was to a great extent

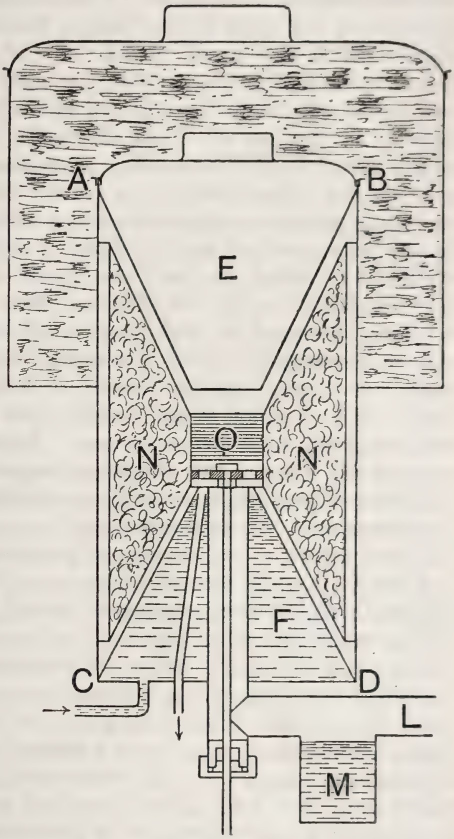

FIG 13.

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* "On the economy of the heating or cooling of buildings by means of currents of air." Proc. Glas. Phil. Soc., Dec. 1852; collected papers vol. i. p. 515.

taken up by this cold water. Then the plunger was made to descend. The air passed through the regenerator, gave up its heat to it, and came out into the upper space comparatively cool. Then, while the plunger was still down, the pump-piston was made to move out, reducing the pressure of the whole contents. Consequently, the air in this space expanded and fell much below its original temperature. Then the plunger was made to move up, and the cold air passed down through the regenerator, cooling it and taking up heat, after which the cycle was ready to be repeated. It is precisely a reversal of the cycle in the Stirling hot-air engine. With this small model, only 5″ in diameter, worked by hand, Kirk was able to cool air so effectively that he could freeze mercury in the cup E. From this model he passed to devise machines working on the same principle on a comparatively large scale.* His immediate purpose was to construct a machine for the extraction of paraffin from paraffin oil, and he carried this out successfully at the Bathgate Paraffin Oil Works. Similar machines, designed by Kirk, were employed also for ice-making; one of them worked for a number of years in an ice factory at Hong Kong. It is recorded of this machine that it produced 4 lbs. of ice per ton of coal. Let us see what this corresponds to when we express it in terms of what I have called the co-efficient of performance. We must make some assumption with regard to the number of pounds of coal which have to be burnt in the steam-engine to produce the horse-power-hour of work. It will be reasonable to assume that the steam-engine which was used to drive Kirk's machine burnt between 3 and 3½ lbs. per horse-power-hour. In that case 4 lbs. of ice per lb. of coal corresponds in round numbers to a co-efficient of performance equal to 1. In other words, it would seem that when Kirk's machine was employed on a fairly large scale in ice-making it produced an amount of cold which was about equal to the thermal equivalent of the work spent upon it. An ideally perfect machine working between about the same limits of temperature would have a co-efficient of performance of say 10, so we see that Kirk's machine fell a long way short of the performance of an ideal machine. Nevertheless, this is probably the very best performance of any air machine of which we have a record. A machine working with air under comparatively high pressure with a closed cycle is under better conditions with regard to the co-efficient of performance than an open cycle air-machine is, and the regenerative principle which Kirk employed had the effect of making the machine come nearer to the condition of thermodynamical perfection than is possible in the open cycle which is used in ordinary air-machines. Hence this co-efficient of performance, although it is only something like one-tenth of the ideal co-efficient, is nevertheless a better performance than air-machines of the more ordinary type ever reach.

But why was it that Kirk's machine gave a performance so small as this? Several reasons contributed to reduce it. In all air-machines there is a fundamental difficulty, very serious in practice, in getting heat into and out of the working substance within any reasonable space of time. In this respect air-machines are at a great disadvantage when compared with machines which vaporise liquid and condense vapour alternately. In the process of vaporising the liquid, and recondensing the vapour, it is much easier to effect the transfer of heat than when we are conveying it to or from a poor conductor like air. An air-machine practically requires that the working substance should, when it is in the hot end of the cycle, be carried up to a much higher temperature than the cooling water to which heat is to be rejected, and again, when it is at the cold end of the cycle that it should be carried down to a much lower temperature than the temperature of the body from which heat is to be extracted. In order that heat may flow out of the air on the one hand, and into the air on the other hand, at anything like a reasonable pace, it is necessary that the difference of temperature between the air and the substance to which it is giving heat, or the substance from which it is taking heat, should be comparatively large. Then, further, another difficulty which existed in Kirk's machine, and exists in all forms of air-machines, is that they are bulky and that the loss of effect through friction in such machines is relatively very large. We must bear in mind that in all refrigerating machines whatever the frictional losses form an item of much more importance than might at first sight appear. For it is not simply that friction means the expenditure of power; but also that friction causes a development of heat within the machine itself, and that the heat so developed has for the most part to be taken up by the working substance. Friction not only increases the work which has to be spent in carrying the working substance through the cycle, but by communicating heat to the substance, it diminishes the net or effective refrigeration which the machine produces. In any form of machine the existence of friction within the machine not only wastes power, but since the working substance has to take up the heat generated by friction, it is left with less capacity for taking up heat usefully.

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* Kirk. "The Mechanical Production of Cold." Min. Proc. Inst. C.E., vol. xxxvii., p. 244.

Kirk's machine is now obsolete, and so indeed are all forms of closed cycle air-machines. Two other inventors' names are associated with machines of this class—Allen, an American, and the German, Windhausen, who has been a pioneer in several lines of invention relating to the mechanical production of cold.

OPEN CYCLE AIR MACHINES.

We come now to the open cycle air-machines, a type which has had far more important application. This is the machine which was foreshadowed by Lord Kelvin in 1852, and also by Professor Rankine about the same time. It was first introduced practically as a means of refrigerating by Giffard in 1873, was afterwards modified by a number of inventors, mainly English, in whose hands it attained great practical success. Mr. Coleman says his attention was drawn to the subject in 1877 by Lord Kelvin, who had been consulted by Messrs. Bell as to the best means of mechanically refrigerating meat during its transit over the sea, and it was in consequence of this that he devised a form of refrigerating machine which afterwards became known as the Bell-Coleman Refrigerating Machine. His type was essentially similar in general features to the machine of Giffard, which had been invented in 1873. Almost immediately afterwards the subject was taken up by Mr. Lightfoot, who proceeded to develop a Giffard machine, improving it in its mechanical details, and introducing new features. About the same time also air-refrigerators were made by Mr. Haslam (now Sir Alfred Haslam), who at a later date took over the manufacture of the Bell-Coleman machine, and in whose hands there probably have been a larger number of air-machines made than have been made by any other constructor. Messrs. Hall, of Dartford, are other makers who have contributed to the extensive use of such machines. It was in the year 1878 that the steamer *Strathleven* was fitted with a machine of this type and made an experimental voyage to Australia, bringing home a small quantity of frozen beef and mutton as part of her cargo. This experiment led to what has now become an enormous trade. The type of machine with which all these inventors' names are associated is substantially in its main features the same. It consists of two working cylinders, a compression cylinder, and an expansion cylinder. The air is taken in by the compression cylinder from the room which is to be maintained at a low temperature: compressed and thereby warmed: then cooled by circulating water while in the compressed state: finally made very cold by expansion to atmospheric pressure, and returned to the cold room from which it came.

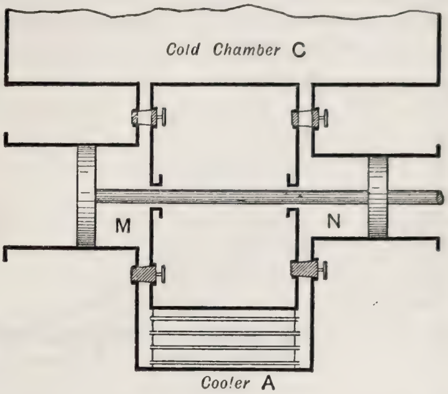

FIG. 14.

In the diagram (Fig. 14) the space, C, represents a room which you may imagine is to be kept at a temperature of something like 18° Fahr. Air from it is taken in by the compression cylinder, M. It is then compressed from 1 to 4 atmospheres or so, and is discharged into the vessel, A, where it is cooled by a circulation of cold water. In the diagram the air is represented as passing into a number of pipes which are kept cool by the circulation of water outside, but in many cases the relationship is inverted, and the air passes outside the pipes, while the cold water passes through them. The air was heated in compression, but the circulating water brings it down to a temperature only a little above that of the water itself. The temperature reached in compression is generally somewhat high. In tests of such machines a temperature of, say, 270° Fahr. is not uncommon. From that temperature the air is brought down to something like 60° by the water, and then it passes, still under high pressure, into an expansion cylinder, N. It is cut off rather early in the stroke, and is allowed to expand until it falls to atmospheric pressure. It is then discharged back into the cold room. In expanding from the pressure in A, of, say, 4 atmospheres or so, down to 1 atmosphere, at which it is discharged, it becomes very much cooled, and reaches the cold room C, at a temperature of perhaps −80° or −100°, or, in some cases, even −120° Fahr. Thus the contents of the room are maintained cold by the removal of a small portion of its atmosphere by each stroke of the machine, and the restoration of that at a temperature much lower than that of the chamber itself. The expanded air requires to be considerably lower in temperature than the cold room in order that a low temperature may be maintained, notwithstanding the fact that heat is continually leaking in from outside by conduction through the walls of the room.

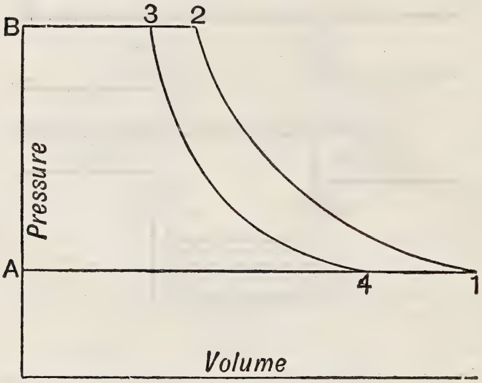

FIG. 15.

Fig. 15 is an ideal indicator diagram of the cycle through which the air is taken in such a machine. The action of the compressing cylinder, M, is shown by the diagram, A 1 2 B, and that of the expansion cylinder, N, by the diagram, B 3 4 A. The area, 1 2 3 4, measures the net amount of work that is expended. In this ideal diagram the compression and expansion are assumed to be adabiatic, and the volume of A, as well as that of C, is assumed to be so great that during the delivery of the air its pressure does not sensibly change. The theoretical coefficient of performance in this cycle is much less than in the perfect cycle of Carnot. it may be expressed as $\frac{T_4}{T_1 - T_4}$ where T_1 and T_4 are the absolute temperatures at the points 1 and 4 of the diagram.

PRACTICAL AIR MACHINES AND THEIR PERFORMANCE.

A number of independent tests of such machines have been recorded, and from the data they furnish it appears that the co-efficient of performance ranges from something like $\frac{1}{2}$ to $\frac{3}{4}$. I do not know of any authentic figures in which the co-efficient of performance is greater than $\frac{3}{4}$, and in every case it is something greater than $\frac{1}{2}$. Why is it so low? In the first place you observe that the actual range of temperature through which the action goes on is very large compared with the range which an ideally perfect refrigerator would employ. An ideally perfect machine would take in its heat when the working substance was only a trifle colder than the cold chamber, and reject its heat when the working substance was only a trifle warmer than the cooling water, whereas the actual range of temperature through which the working substance is carried in an air-machine may be from —80° Fahr. up to 270° Fahr., when the chamber is at 20° Fahr., and the water at 60° Fahr, The widening of the range in this way is of itself a sufficient reason for a comparatively low co-efficient of performance. It is easy to show on theoretical grounds that such a machine could only be expected to have under the most favourable conditions a co-efficient of about two, and from that you must discount various other sources of loss, such as friction, and the influence of moisture.

The influence of moisture in such machines is a point to which much attention was paid by the earlier inventors. A distinction in the Bell-Coleman machine was this, that a special arrangement was employed for extracting as much as possible of the moisture from the air before it should be allowed into the expansion cylinder. In the early types of machines of this kind a good deal of difficulty was experienced from the formation of snow in and about the expansion cylinder and its valves. The air coming from the cold chamber is generally saturated. During compression there is no tendency to deposit moisture, for the rise in temperature more than compensates for the rise in pressure. But when the air passes into the cooler it may deposit moisture, especially if the cold chamber is not very cold. For example, air coming saturated from a room at 20° Fahr. would be nearly, but not quite, saturated after compression to four atmospheres, and cooling to 60° Fahr. But if the cold room is considerably warmer than that, and the air is saturated as it leaves, moisture will separate in the cooler. In any case, even if the air leaving the cooler be not saturated, its further reduction of temperature in the expansion cylinder will tend to super-saturate it, and the early inventors were so much impressed with the deposit of snow as a practical difficulty, that they not only endeavoured mechanically to remove any particles of liquid as the air left the cooler, but they used means of extracting part of the water which was held in solution by reducing the temperature of the air to something lower than that of the cooler itself before it was allowed to complete the cycle by expansion. Mr. Lightfoot adopted the plan of dividing the whole expansion into two stages. He made the expansion compound, using a single cylinder with a piston which was made annular on one side by means of a trunk. On that side the air was expanded down to a temperature just above 32° Fahr., and on the other side its expansion was completed. In the first stage no snow was formed, since the temperature was not low enough, but water was deposited, and that was drained away before the air passed over to the other end of the cylinder. In the Bell-Coleman machine a different device was adopted with substantially the same object, namely, a series of drying pipes forming an interchanger, by which the cold air coming from the chamber was made to further cool the compressed air after it had passed through the cooler, A, and before it was allowed to expand. The current of air in the drying pipes was adjusted so that the temperature should fall to something near 32° in order that as much of the moisture as possible should be deposited as water (and not as snow) before the air should pass into the expansion cylinder. This device is still used by Messrs. Haslam in their cold-air machines. Other manufacturers have now given up any method of specially cooling the air before expansion—that is to say, of cooling it lower than the temperature at which it naturally leaves the cooler, and they are content to effect a mechanical separation of the particles of moisture which are mixed with the air at that stage. They make no effort to extract that part of the moisture which is contained in the form of vapour in the air, and only mechanically extract what has already been converted into the form of water. They find that no serious difficulty is experienced from the deposit of snow during the expansion if the air is only saturated and is not charged with liquid particles before expansion begins. It is true, of course, that the deposit of snow will be somewhat greater than if an interchanger of the Bell-Coleman type be employed; but the deposit is not so great as to affect the working of the valves, and the only inconvenience appears to be that the snow-box, into which the air is discharged after expansion before it goes on to the chamber, has to be swept out oftener in one case than the other.

In the large air-compression machines made by Messrs. Haslam a pair of compound steam-cylinders are placed horizontally side by side, and each is arranged in tandem with one compression and one expansion cylinder. So far as the air-cylinders are concerned, the machine is duplex, and one or both pairs may be used at pleasure. Each air-expansion cylinder has valves of the same type as those common in steam cylinders. Meyer expansion valves are used, and are worked by prolongations of two rods, which work the corresponding valves of the steam cylinder. The compression valves consist of a group of discs placed on the cover of each compression cylinder. Large machines of this kind may be seen working in London at the Victoria Docks, each taking about 300 horse-power to drive it, causing 170,000 cubic feet of air to pass through it per hour, cooling the air to about $-70°$ Fahr, and serving to keep cold a store of 340,000 cubic feet capacity by running in general some eight hours a day. The compression cylinder is water jacketted, so that a certain amount of the heat which is developed during compression is extracted from the air before it goes to the cooler. The more heat that can be so extracted the better for the efficiency of the machine. In Mr. Coleman's early machines the temperature of the air during compression was kept comparatively low by injecting water into the cylinder. This water injection is open to many practical objections, especially when sea water is concerned, and surface cooling is now exclusively used.

The large air-machines of Messrs. Hall are very similar in arrangement to those of Messrs. Haslam. The largest is 32½ ft. long, 12 ft. wide, and 6½ ft. high, and circulates 250,000 cubic feet of air per hour. A great variety of air-machines of smaller power are sold by the makers I have named, and also by Mr. Lightfoot, down to belt-driven machines circulating as little as 3,000 cubic feet per hour.

Air-machines have played a large part in developing the commercial applications of cold, although now the first place is taken by other types. When the problem is to produce a cold atmosphere in a chamber the air-machine is not at the same obvious advantage as when we are concerned with the production of cold in a liquid. I pointed out that when air is used as a medium to extract heat from a liquid, the difficulty which is imposed by the bad conducting power of the air operates as a serious practical drawback. This objection does not apply in anything like the same degree where we are concerned with the production of a cold atmosphere. Air can be employed as a medium for cooling itself more efficiently than it can be employed as a medium for cooling anything else. Again, air-machines use a working substance that is simple and harmless, and that costs nothing. When we come to deal with machines employing as working substance a liquid and vapour we find in practice very much higher coefficients of performance than are obtained with air, and therefore better economy of power. Nevertheless, in spite of their relatively large consumption of power, air-machines still do a considerable share of the refrigerating work that is done on board ship. For other uses, the air-machine would not now be recommended, but for ship-board use it retains the favour of some engineers, although even there it now has two very serious competitors in the vapour-compression machines using ammonia and those using carbonic acid.

International Congress on Technical Education.

FRIDAY, 18TH JUNE.

SECTION B.—*(continued).*

Major-General Sir OWEN TUDOR BURNE, G.C.I.E., K.C.S.I., in the chair.

TECHNICAL EDUCATION IN CANADA.

BY W. PETERSON, M.A., LL.D.

Principal of McGill University, Montreal.

I have been honoured by a request that I should make a communication to the International Congress on the existing condition of Technical Education in Canada. My own residence in the Dominion is of too recent a date to confer any claim to knowledge at first-hand of all that is going on in this department in the various centres of so vast a country; and I am glad to notice that the Superintendent of Education in Nova Scotia has forwarded a separate report, which will relieve me of the necessity of including that district in what must be at best a very rapid summary. On the other hand, in virtue of the position which I have the honour to hold in Montreal—the commercial metropolis of Canada—I have enjoyed exceptional opportunities of acquainting myself with educational circumstances of every kind; and I had, therefore, little hesitation in accepting the invitation received just as I was about to start on what may be called a "business holiday" on this side of the Atlantic. And in venturing to speak on the subject of technical education, without any very obvious credentials except such as may belong to my official position, I take leave to remind my audience that, while Principal of the University College of Dundee, I followed very closely the great impetus that was given to the whole subject in this country by the presentation to Parliament of the Report of the Technical Commission, many of whose members are still actively at work on the subject to which they devoted at that time such ungrudging effort. I believe that I may even claim to have originated—in a suggestion made to my late colleague, Professor Carnelley—the Dundee and District Association for the Promotion of Technical and Commercial Education, which has done such excellent work in the way of co-ordinating educational agencies in the east of Scotland, under the able guidance of Mr. Frank W. Young, and others.

Most of us whose life-work lies rather in other departments of study, find ourselves under the compulsion of approaching the whole subject of technical education as Sir Joshua Fitch did the other day, with a certain *caveat.* From one point of view—as the superior person will tell you—it is not education at all. It is not the training of the whole man for a whole life: it is the training of that part of a man which finds its expression in the pursuits and associations which he may elect to follow. Technical education is so important because very few, comparatively speaking, of the rank and file have time to think of anything except these pursuits and avocations. Their own industrial efficiency, and the industrial efficiency of the nation which they represent —especially in these days of strenuous foreign competition—are with them the paramount considerations. Old views and antiquated systems of education must go to the wall, they say, in the face of the unanswerable demands made by existing circumstances. The industrial and commercial prosperity of a country lies with its rank and file, and for them the most useful and practical form of education will be that which renders them more efficient in the performance of the work that lies in their hands. *Work* is what they must be educated for: the *leisure* of life can be left to take care of itself.

It is not at all surprising that, under the stress of competition with foreign nations, technical education should have become so important and so engrossing a subject in

England. A country which shows such a disregard of tariffs must do something to justify its policy. The present condition of things in Canada is somewhat different. You have there a vast extent of country, with a more or less scattered population, whose industries are still only partly developed. In the earlier days of business enterprise, when individuals had the opportunity of making great profits out of large and lucrative monopolies, there may have been something of a spirit not unknown in industrial centres even in this country—the spirit of a selfish distrust of anything that might result in sharing with the many what Providence seemed to have designed as the property only of a few. But, as the general outlook widened with the growth of the country, the view came to be more generally admitted that the prosperity of a people, and the success of its various enterprises, depend, not on individuals alone, but on the whole body of those who derive their livelihood from the occupations in which they are engaged. And certainly in Canada no greater efforts have anywhere been put forth on behalf of technical education than those that are made in the great commercial centres of Montreal and Toronto. The mind of the country seems to be taking hold of the true view of such education, viz., that it "aims at improving the capacity (in a broad sense) of all those on whom the national industries depend,—not by disparaging general education, but by giving increased attention to the principles of art and science which underlie the industrial work of the people at large."

In the main, then, I think I am able to report that the great fact has been grasped that the interests of technical education can best be promoted—certainly in its less advanced stages—by the introduction of certain changes into the system of which is known here as primary and secondary instruction. Object lessons, elementary science, drawing, and simple manual training—these are departments in which great advances have been made of recent years in most of the important centres of the Dominiou. In future progress I trust that due weight will be given to the interesting record of such work as is done in the unrivalled *Realschulen* of Berlin, which goes to show that the best and soundest basis for technical education, as indeed for every form of higher education, is to be found in the carefully arranged curriculum of the junior school.

The note communicated to the Congress by the Superintendent of Education for Nova Scotia will, no doubt, deal with the conditions of technical education there, and also in the maritime provinces generally. In the higher departments, Dalhousie University at Halifax, and also King's College, may be mentioned as institutions which endeavour to take a broad view of the functions of a university.

Another important province can only be named in this connection—British Columbia, whose prosperity is too recent to justify us in expecting, as yet, much organised effort in this department of educational activity. You know what the main industry of British Columbia is at the present time ; and it may be of interest to state here that, with a view to training the youth of the country—and others—and to take advantage of the great mineral wealth of that region, we have lately established at M'Gill University, and are now equipping, a school of mining and metallurgy, which will be unrivalled in Canada. When I say that the institution of this school was made possible by one of Mr. W. C. M'Donald's princely benefactions—and M'Gill has profited by Mr. M'Donald's munificence to the extent of over half a million pounds sterling—you will appreciate the scale on which its lines have been laid down.

My summary must deal mainly then with the older provinces of Quebec and Ontario. In the last-named province—Ontario—the true basis for technical education is being thoroughly laid by the introduction of kindergartens and more advanced instruction in the public schools. Moreover, there was introduced into the Legisture, last session, a very thorough-going measure, which provides for the establishment of technical schools on a considerable scale. Particular importance is attached to such arts and sciences as relate to the industries of the province, the marketable value of the raw material used in manufactures, the chemistry of foods, dyes, and minerals. Instruction may also be given in agriculture and domestic science, and in architecture, mechanical drawing, and decorative design, and such other related subjects as may be found necessary to render the labours of the farmer, the mechanic, and the artisan more productive. The buildings to be used for technical school purposes are to be separate and distinct from the buildings used for High School purposes. The Minister of Education for Ontario, the Hon. G. W. Ross, is sanguine enough to "hope that under this Act the province will, in course of time, be covered with technical schools, as it is now with High Schools."

Similarly by the Act respecting public libraries, which is already in operation, provision has been made for a limited number of courses of technical instruction in such evening classes as may be organised by the Boards of Management having charge of the public library. And towards the maintenance of such schools moneys are annually appropriated by the Legislature.

Statistics are available showing a steady increase in the number of pupils attending the art schools and departmental drawing examinations since the year 1882. The primary course consists mainly of geometry and drawing: the advanced course includes shading and ornamental design. The mechanical drawing course embraces the subjects commonly taught in similar curricula on this side of the water—descriptive geometry, machine drawing, building construction, design (industrial and architectural), and advanced perspective. Extra subjects are also encouraged, such as modelling, engraving, and wood-carving.

At Toronto a technical school has been established, and is maintained, by the City of Toronto for the purpose of providing, by way of evening classes, technical education for all sections of the community, free of charge. In the Session, 1895-6, this school was attended by 739 pupils, of various ages and occupations. The programme of instruction is drawn up on lines with which we are familiar in this country in connection with the Science and Art Department and the City and Guilds Institute.

Moreover, there is at Toronto a School of Practical Science, affiliated to the University, in which courses of education are provided in civil engineering, mining engineering, mechanical and electrical engineering, architecture, and analytical and applied chemistry.

At Kingston there is a School of Mining and Agriculture, which receives an annual subsidy of $8,600, and is affiliated to Queen's University. In connection with this school, classes for prospectors are arranged during the summer months, as is also the case in the School of Practical Science in Toronto, just mentioned.

A special feature of the Kingston Institution is, however, the Dairy School, under the control of the Provincial Government, which offers instruction in cheese and butter-making.

Lastly, it should be noted that at Kingston a Faculty of Practical Science has recently been established in Queen's University. Workshops have been erected, and are already fairly well equipped, as regards mechanical engineering.

PROVINCE OF QUEBEC.*

I.—Roman Catholic Schools.

In these schools special attention is given to such useful accomplishments as knitting, sewing, embroidery, cooking, &c., all being included under the general head of "Manual Training." The following summary from the report of the Superintendent of Public Instruction will show what is attempted in this connection:—

Laval Normal School.—Pupils are taught to knit, crochet, embroider, and to sew and cut out clothing. Theoretical lessons are also given in domestic economy and cooking.

Sillery Convent.—Pupils are taught knitting, plain sewing, crochet, and hemming. The higher classes are taught embroidery. Certain of the pupils are also taught dress cutting and cooking.

Ursulines of Quebec.—The pupils here are taught to cut out, to make and repair their linen and dresses, and to do all kinds of knitting and embroidery. They also receive lessons in economy and ordinary household work.

Asylum of the Sisters of Charity, Quebec.—Here the pupils do the usual household work and are afterwards occupied in groups in unravelling and winding worsted, in carding, spinning, weaving cloth, flannels, and rag carpets. They also make dresses, cloaks, aprons, &c.

Sisters of the Assumption, Nicolet.—The pupils are taught stitching, hemming, sewing, and mending; also a little embroidery.

Sisters of Providence, Montreal.—(1) The deaf mutes are instructed in sewing, knitting, weaving, &c., and in doing all kinds of work, from rag carpets to the finest embroidery. They also do the household work, cooking, washing, gardening, &c. (2) The orphans are taught sewing, knitting, &c., and the usual household duties.

In the orphan asylums at Three Rivers and Joliette the pupils are taught gardening, butter-making, spinning, weaving cloth and linen, and all the domestic work usually done in a farmhouse.

The boarders in the establishments of the Sisters of Providence are taught sewing, knitting, mending, housework, &c., and in some of them farmwork. The day scholars in these establishments are taught sewing and knitting.

Monastery of the Good Shepherd, Montreal.—The pupils are trained in all kinds of sewing, embroidery, all kinds of knitting, house-cleaning, and cooking. Also in horticulture, apiculture, and agriculture.

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* For various details of information contained in this paper, the writer is under obligation to Dr. Bovey, Dean of the Faculty of Applied Science in M'Gill University; also to Mr. E. W. Arthy, of the Protestant Board of School Commissioners, Montreal.

Community of Les Saints Noms de Jesus et de Marie, Hochelaga.—The pupils here are made to go through a regular course of sewing and learn to do all kinds of mending, knitting, and darning; also to make and cut out clothes. They are further instructed in crochet, tapestry, lace-making, and embroidery. They receive practical lessons in housekeeping and in cooking.

Lachine Convent.—Pupils are instructed in needlework, sewing, and knitting of all kinds, in cutting out clothing, &c. They also do embroidery, knitting, lace-making, &c., and receive instruction in cooking.

Convent of La Presentation de Marie, St. Hyacinthe.—The pupils here are instructed in plain sewing, knitting, dress-cutting, and fancy work, and receive theoretical lessons in domestic economy, housekeeping, and cooking.

Congregation de Notre-Dame, Montreal.—In the many establishments of this community throughout the province the pupils are taught knitting, sewing, embroidery, cutting-out, &c., and receive special lessons in domestic economy, practical house-cleaning, and cooking.

Roberval, Lake St. John.—Here the pupils (girls) receive lessons in agriculture and horticulture, and are instructed in the management of the dairy, creamery, garden, kitchen, and poultry-yard, &c. They also learn to weave linen and cloth, and to work wool and flax in a variety of ways.

II.—Protestant Schools.

Kindergartens.—Kindergarten departments have been established in all the high and public schools in the city of Montreal. The course in the kindergarten deals with: (*a*) solids, by means of clay, sand, and cardboard work; (*b*) surfaces, through paper-folding, paper-cutting, and painting with brush; (*d*) lines, by means of weaving, sewing, and drawing; (*e*) points, by means of bead-stringing, perforating, &c.

The manual work begun in the kindergarten is systematically carried on in the junior classes of the schools under the head of form study and drawing. This includes paper-folding and paper-cutting, stick-laying, clay modelling and colour work. The results of the work in this direction have been very satisfactory.

Educational Sloyd forms a regular part of the course of the Boys' High School. This course is compulsory for all children attending the school, and is taken in the regular school hours. The girls have to undergo a three years' course in sewing, consisting of a series of weekly lessons in ordinary plain sewing and in making small and simple articles whose form has been more or less fully developed or suggested by the drawing and paper-cutting lessons. Special instruction is given in cookery in certain of the schools.

In the senior school industrial drawing and colour work of a practical and technical character are special features, the object being to prepare pupils to make original working designs for wall-papers, oilcloths, carpets, silks, cretonnes, &c.

In the primary school the pupils are instructed in the method of modelling geometric forms in clay; the boys are taught carpentry under a skilled mechanic.

In the model schools connected with McGill Normal School, sewing and wood-work have been carried on for some time, with marked success.

The School Commissioners have established a cookery school in the new Aberdeen School, to which pupils are drafted from the senior classes of the public schools.

In the province generally, provision has been made for elementary technical education as follows:—

MONTREAL—
 Freehand, Senior.
 Freehand, Junior.
 Mechanical.
 Mechanical (Pt. St. Chs.)
 Architectural.
 Model & Wood Carving.
 Lithography.
 Decorative Painting.
 Stair Building.
 Plumbing.
 Boot & Shoe Pattern.
 Ladies' Dress Cutting.

QUEBEC—
 Freehand.
 Architectural.
 Mechanical.
 Stair Building.
 Plumbing.

LEVIS—
 Freehand, Senior.
 Freehand, Junior.
 Mechanical.
 Geometrical & Architectural.
 Modelling.

SOREL—
 Industrial.

ST. HYACINTHE—
 Industrial.

SHERBROOKE—
 Freehand.
 Mechanical.

THREE RIVERS—
 Freehand.

The total number of pupils taking advantage of the courses in the different centres during the past year was 851.

McGill University, Montreal.—I venture to express the hope that many members of this Congress may find their way out to Canada in order to attend the forthcoming meeting of the British Association. They will find that provision has been made for their reception in Montreal on their way up to Toronto, and this will give them an opportunity of inspecting the unrivalled equipment of McGill University, especially in the departments of Engineering, Physics, Chemistry, Mining, and Architecture.

Advanced courses of education are given at McGill in the following six departments :—Architecture, Civil Engineering, Mechanical Engineering, Electrical Engineering, Mining Engineering, and Practical Chemistry.

It is impossible to mention these departments without again referring to the name of Mr. W. C. McDonald, to whom—as well as to Sir Donald A. Smith, now Canada's High Commissioner—McGill is mainly indebted for the high place it holds to-day among the universities of the world.

This summary of what is being done in Quebec and Ontario, taken along with Dr. Mackay's report on Nova Scotia, may be held to cover the subject on which I was invited to speak. The activity of the various Canadian centres in the field of education generally has given rise to apprehensions in some quarters. The fear is sometimes expressed that we are over-educating our people. I do not share this anxiety. It is, of course, an offence against soicety to take from the plough a man who would do good work as a ploughman and make of him a third-rate lawyer or doctor. But in Canada, as elsewhere, there are natural laws which redress such inequalities ; and even if it be a fact that many of our highly-trained graduates find their way at present across the "line" to work in the United States, this will not always be the case. The country has been preparing during a long series of years for the expansion and development that cannot fail to come. Those of its sons who elect to labour in other fields carry with them the high traditions of their training, and increase the respect which is justly entertained in many American centres for Canadian educational methods and institutions. There is not a university in Canada which does not aim at giving a highly practical character to the education offered within its walls. For those who posses the necessary leisure, there are, of course, schools of classics and philosophy ; and, side by side with these, I hope there will grow up in time departments in which, through increased opportunity of studying economical, social, and even political questions, the youth of the country will be trained for the highest duties of citizenship. The career of public men—even of journalists—in Canada will be all the more useful in the future because of the practical ideas which animate the administration in all the various centres of higher education. So long as we can say we are "giving the people what they need," there is little fear that we are giving them too much of it. Dairy schools, agricultural colleges, and departments of mining and metallurgy, are obviously of the highest importance for a country which has such possibilities of development in these and cognate directions ; and successful operations in such fields of educational endeavour will be none the less fruitful, and none the less permanent, because they are for the most part carried on in centres which do not limit themselves to this purely technical activity. The educational institutions of Canada are doing what they can to prepare the youth of the country, not for professional careers alone, but for the whole life. When the last railroad has been laid, the last bridge built, and the last mine exploited, there will remain, deep down in the heart of the people, the consciousness that these were not alone the things worth living for—the only triumphs that glorify a nation's energies. The fruits of the efforts that are being put forth to-day will be fully gathered when the high traditions of the liberal education which Canadians hold so dear have become part and parcel of the national well-being of the country ; and when our young men, brought up through successive generations in the highest forms of intellectual nurture, as well as practical accomplishment, shall stand forth as examples to the world of all that is best and truest in a nation's progress.

TECHNICAL EDUCATION IN NOVA SCOTIA.

By A. H. MacKay, B.A., B.Sc., LL.D., F.R.S.C.,

Superintendent of Education for the Province of Nova Scotia, Canada.

The population of Nova Scotia in 1891 as given in the last census report was 450,523. Of these a little more than one third reported themselves as "wage-earners" or having "occupations" from which came the general support of the whole population. They are generally classified as follows :—

Occupied in Agriculture	53,340
,, ,, Mining and Fishing	29,893
,, ,, Manufactures and mechanical work	26,541
,, ,, Domestic and personal service or trades	23,463
,, ,, Trade and transportation	18,117
,, ,, The learned professions	6,100
,, ,, Spending time, energy or income	2,619
Total	160,073

These figures give an approximate idea of the proportion of the different future employments of those who should be educated. The education of the mothers of families, who with the unemployed children are not included in the list of "wage-earners," should, for reasons which need not now be assigned, be even more general and practical than that of the average wage-earner.

THE PUBLIC SCHOOL SYSTEM.

In 1864 the public "free-school" system was introduced, followed the next year by an enrolment of about 24,000 pupils at a cost per annum of about $212,000 to the Province and the School Boards. The total enrolment in 1896 was 101,032 which cost $813,335 for the year. The public school course of study is very definitely organised, having eight (annual) grades in the "common" school (where possible with an additional year of Kindergarten for pupils under five years of age) and four grades in the "high" school, making altogether a twelve year course free to all who are able and willing to take advantage of the same. In the high school grades ancient and modern languages are optional subjects to the student; while drawing, book-keeping, geography, and the elements of the natural sciences are imperative up to the end of the eleventh year. The completion of the work of each year of the high school course in a satisfactory manner, as demonstrated by the annual terminal provincial examinations, is recognised by the award of a certificate containing on its margin the percentage marks given by the Board of Provincial Examiners on each subject; thus, even should the certificate be not a "pass" from one grade to another, it may still serve the purpose of exempting the holder from the passing of an examination upon particular subjects in the matriculation of students into the various colleges, &c. In other words, the high school system is a sort of a provincial university, under which all the high schools and academies (the latter being simply high schools which, on account of the provision made by them for the free accommodation of all qualified students in the county who wish to attend, receive a special grant called the County Academy grant) are federated.

DEVELOPMENT OF THE INDUSTRIAL SENTIMENT.

For some time there has been a growing impression that the courses of study in the schools of this continent were tending to stimulate the youth of the country more proportionately towards the literary and learned professions in which, as shown in the table above, but some 6,000 out of 160,000 are employed in Nova Scotia, than towards the industrial occupations in which the masses are engaged. As the sentiments determining the trend of the occupations of the future citizens are generally called into existence during the period of common school life, it was deemed advisable to so modify the old literary courses from the kindergarten up to the high school as to develop *pari passu* the industrial and patriotic sentiments and a sense of the dignity and pleasure of intelligent and skilled labour. This is now attempted to be done by "nature study," &c., the accurate observation and correlation of all the common phenomena, natural and artificial, in each locality, rising up to the character and working of our national institutions and the glorious inheritance of our best traditions.

Since 1893, the Provincial Normal School admits as candidates for the professional qualification of teachers only such as have already passed the required standard of scholarship at the provincial high school examinations. While pedagogy, the practice and theory of education, &c., as in normal schools generally, are important subjects in this institution in addition to the general polishing of work already more or less completed in the high schools, special stress is now laid upon the further development of the practice and teaching of simple modelling in clay, freehand and mathematical drawing, woodwork and the use of tools generally, practical demonstrations in physics, chemistry, botany, geology, entomology and general biology, in agriculture, horticulture, dairying &c. Manual training subjects, and such as cookery, can be introduced into any school at the option of the boards of trustees of the school sections. The Provincial Normal School at Truro is affiliated with the Provincial School of Agriculture about a mile distant, and all candidates for a diploma are required to take one or more subjects according to the class in which they are entered, so that they may be prepared to give successful object-lessons adapted to the industries of the school sections in which they may sometime be engaged. The teacher is expected to be able to develop in the pupils, from the lowest grade upwards, the habit of accurate observation and the study of all common phenomena and objects, with the action and interaction of law, natural, social, and civil, so far as exemplified in the local environment. This habit it is hoped, may make the work of the common schools more valuable as a general foundation for all professional and even literary careers, as well as for the varied and increasingly complex industrial conditions of our times. While a scientific interest and an intelligent pleasure may in many cases be thus created in occupations otherwise uninviting or repellent, the scientific principles conditioning their most successful exploitation are simultaneously revealed. These object-lessons of the common schools are carried on in a more specialised form in the several grades of the high schools.

SECONDARY TECHNICAL EDUCATION.

Affiliated to the public school system or otherwise aided by public grants are the following institutions of secondary rank which do work in general technical education :—

1. The manual training department of the Provincial Normal School at Truro was established as at present in 1893. The attendance in 1896 was the 144 students of the Normal School. There is also a manual training department in woodwork, opened in Halifax in 1891, free to selected classes from the highest grade of the common schools and the lower grades of the high schools. In Wolfville, established shortly after this Halifax school, there is the best equipped school of the kind in the province, including in its course ironwork as well as woodwork. It can be utilised by the public schools of the town and by Acadia College in its immediate vicinity, but it receives no provincial or civic grant, and is supported by fees in addition to the original private foundation bequeathed to the institution.

2. The Provincial School of Agriculture at Truro, established in 1885, has now two instructors, in addition to the manager of the farm. The attendance in 1896 was 81 for full and special courses, besides the 141 students taking the Normal School special courses. The school has conveniences for the practical study of all branches of agriculture and horticulture and dairying. The school building proper is fitted up with qualitative and quantitative chemical laboratories, a dissecting-room, biological laboratory and apparatus, reading-room, and technical library. Under the annual inspection of the principal of the school, there are five local agricultural schools in the charge of graduates, who also conduct, in affiliation with the agricultural work, the ordinary public schools of the section.

3. The Provincial School of Horticulture at Wolfville was established in 1893, by the Fruit-growers' Association, with the aid of an annual grant of $2,000 from the Provincial Government. The attendance in 1896 was 67.

4. The Mining Schools were established within the last three or four years. They are carried on under the direction of the Inspector of Mines. By the Mines Regulation Act, all managers, underground managers, and overmen are required to hold certificates of competency gained by examination. These examinations are conducted in writing by a Board representing equally the mining profession, the employers and the employees. Instructors are appointed at the principal mining centres, and are charged with the preparation of candidates for examination. The courses extend over the winter months, and the instructors are paid according to results. The candidates for certificates as managers have no special instructors, they being usually men already holding underground managers' certificates, and having at their disposal one or more instructors capable of imparting the additional information distinguishing managers from the lower grades. A large number of men have successfully passed these examinations, and now fill the positions of trust about our coal mines. In 1896 40 certificates were issued to managers, underground managers, and overmen. A similar system of examination and instruction is pursued in the case of men employed about machinery used for raising and lowering persons in mines. There are three classes of these certificates, and altogether there were 16 granted during 1896.

5. The Victoria School of Art and Design was established in Halifax in the year 1887, in commemoration of the fiftieth anniversary of the accession of Her Majesty Queen Victoria. It is subsidized annually by grants from the province and the city. There is a staff of four instructors, and the attendance of students for 1896 was classified as follows :—Freehand and object drawing, 34; painting and life class, 19; senior mechanics, 10; junior mechanics, 22; architecture, 21; children's class, 10; deaf and dumb, 23. Total 139. It must be remembered in noting the number of students in this institution that many of the subjects taught here are also taught in their elementary stages in the public schools and in the ladies' colleges and convents. As more

progress is made the character of this institution will further advance, confining its attention to the higher art and design education—which it already successfully affects.

6. A school of cookery has lately been opened in the city of Halifax, in connection with the public schools and for more advanced work. It is proposed to give the choice of a course to all the girls in grade seven (12 to 14 years of age) in the schools of the city in return for a grant from the School Board.

PRIVATE SECONDARY TECHNICAL EDUCATION.

There are three ladies' colleges and two conventual colleges which give attention to the development of art and some of the practical applications of the science of common things. There are two small navigation schools, although the mathematical principles of navigation are imperative in the third year of the high school course. There are at least two institutions which give special attention to commercial subjects, although in the first and second years of the high schools the principles of book-keeping are imperative. The "Business College" at Truro reports 55 different students during the last year, and the "Commercial College" at Halifax, 225. Much of the work of these institutions is elementary in its character, so that the figures of attendance would not be an index of the amount of work of secondary rank.

THE UNIVERSITIES.

There are no less than seven universities and institutions having degree-conferring powers in the province. Their main statistics are summarized in the following Table :—

Name.	Locality.	Date	Affiliation.	Students 1896.
Dalhousie	Halifax	1863	Undenominational	326
Acadia	Wolfville	1838	Baptist	121
Pine Hill	Halifax	1820	Presbyterian	54
King's	Windsor	1790	Episcopal	32
St. Francis Xavier,	Antigonish	1854	R. Cath. (Eng.)	(*a*)
Sainte Anne	Church Point	1890	R. Cath. (Fr.)	(*a*)
H'f'x Medical Coll	Halifax	1867	Undenominational	(*b*)

(*a*). These two institutions in addition to their functions as colleges, serve also as high schools, and are able to draw the county academy grants for their respective counties, on account of their legal affiliation with the public school system. The respective enrolments of the two, 112 and 18, returned as high school pupils, contain some who do other work than is done in the 18 county academies generally, the sum total of whose regular attendance was 1,532 for the year ended 1896.

(*b*). Most of the students for the Halifax Medical School are also enrolled in the Medical Faculty of Dalhousie, and are therefore not entered here.

Ruling out theology, medicine and law, as I did the pedagogy of the Normal School, which belongs to the "professional" rather than the "technical," taken in its narrower, etymological meaning, and applied science which is not beyond the secondary education, the work of only three of the above-named institutions need be referred to.

Acadia College has its professors of the ordinary sciences, but during the year ended 1896, graduated only Bachelors and Masters of Arts and a Doctor of Divinity. Yet, in the arts course, science subjects are taken; and the proximity of the Manual Training School and School of Horticulture, already referred to, permit the taking of some of their classes in the college course.

King's College has two professors in its staff of seven who have charge respectively of the following subjects :—(1) mathematics, natural philosophy, and engineering; (2) chemistry, geology, and mining. Eleven of the eighteen students enrolled in the arts course are reported as taking science subjects as substitutes for, or in addition to, "arts" subjects.

Dalhousie College returned nineteen as enrolled in the science faculty, exclusive of 197 in arts, some of whom took science subjects. Dalhousie also had 50 in medicine and 60 in law. Thus, proportionally, the number in science is nearly as small as in the other institutions. The faculty of applied science has six professors who are also members of the arts faculty, and 14 special lecturers. In addition to the mathematics, physics, chemistry, &c., also found in the arts courses, the following classes have been formed :—assaying, mineralogy, applied mechanics, descriptive geometry, civil engineering, surveying, mining, hydraulic engineering, municipal engineering.

The province of Nova Scotia is not dependent on its own universities, however, for its students are found in great numbers in the universities and technical institutions abroad. The great Canadian university of McGill, at Montreal, has especially served her young men in medicine and applied science. The cosmopolitan instinct of our students has thus in the first place not allowed the province to suffer from the lack of more advanced and wealthy institutions, but in the second place it has also contributed to the slowness of the development of these institutions.

The greatest obstacle in Nova Scotia to the highest development of university education and of advanced scientific training and its technical applications, is the unfortunate multiplication of inferior universities as denominational colleges, the only denominational institution confining its work entirely to theology being that of Pine Hill. The injury to advanced education is universally felt and generally acknowledged; but the separation once having obtained, the local and sectarian attachments formed will for many years impede all movements towards consolidation.

If the industrial tone now being introduced into the public schools develops with the hoped-for vigour, within the lifetime of half a generation it should begin to result in a rapid extension of advanced technical education. This should be especially true in the case of the metropolitan university which already numbers as many students as all the others combined, and possibly also in connection with the public school system which has already developed such elementary and secondary technical training as has been referred to in this paper.

Miscellaneous.

TEA AND TOBACCO IN THE CAUCASUS.

The cultivation of tea in the Caucasus is annually assuming larger proportions; and samples of tea grown on the plantations at Chakva, belonging to the Imperial Domains, to Messrs. K. and S. Popoff and Colonel A. A. Solovlzoff, were exhibited last year at Nijni Novgorod. H.M. Consul at Batoum says that, in the opinion of competent persons, although the tea crops are as yet almost nil, nevertheless its cultivation will in time develop, and it is hoped that Russian-grown tea will become a general article of trade in that country. Tobacco is chiefly grown in the districts of Soukhoum and Tchernomoria, and its cultivation is mostly carried on by Armenians and Greeks from the vilayets of Samsoon and Tribizond. The land selected by them for tobacco plantations is virgin soil, cleared from under forest which is rich in organic matter and mineral substances, and which yields remarkably abundant crops. After cultivating tobacco for from two to three years, the land is abandoned for this crop and maize is sown upon it, and the tobacco planters purchase and prepare fresh crops for tobacco culture. The average crop obtained from a dessiatine is 70 to 80 pouds (about 950 to 1,050 lbs. per acre). The soil is not enriched in any way, as there is a large quantity of fresh land available, which the growers are always able to obtain on lease, but the soil of the nurseries where the seed is sown requires manuring and careful working, and for this purpose well-protected land is selected. The seed is imported from Turkey. Sowing operations are commenced in March and end in May. The seedlings are planted out in the following year, in April and May. The tobacco-plant flowers about June or July, and the collection of the leaf is commenced about the latter end of July and is continued until November, when the leaves are dried. The drying process occupies about three weeks.

WINE INDUSTRY OF VICTORIA.

The quantity of native wines annually consumed in the colony of Victoria is about 300,000 gallons, about half of this quantity being sold in the wood. The principal wines produced are claret, burgundy, hock, chablis, reisling, shiraz, hermitage, chasselas, sauvignon, tokay, port, and sherry. Some of these wines are the blends of two or three kinds of grapes, while others are made from the juice of one grape alone. The names of the principal varieties of grapes are the burgundy, matars, pineau, hermitage, chasselas, tokay, reisling, and sauvignon. Many of the wines made, take their names from the grapes, and for cheapness, may be said to come within the reach of all. The Customs returns for the year 1895, show that there were exported from Melbourne, 16,650 gallons of bottled wines, 345,417 gallons in the wood, and 3,122 gallons of champagne. The wine growers of the colony lose no opportunity of introducing their wines to the public. Many of them, says the United States Consul-General at Melbourne, have taken first prizes at the different exhibitions of Europe for the character and quality of their wines. At one time the Government allowed a small subsidy to the principal wine growers, though of late years this has not been paid, with the single exception of one vineyard which is a sort of training school in viticulture. This institution receives a subsidy of £150 a year, and young men are received and thoroughly instructed in all that tends to make them successful wine growers. The vineyard, says Consul Maratta, is large and extensive, and thoroughly practical men are employed as instructors. Fine wines are grown there, and there is every facility for thoroughly acquiring the trade.

INDIAN PAPER MILLS.—There are in British India, at the present time, nine paper mills in work. The Indian output for 1896 being 40,707,589 lbs., value of 58,71,159 rupees, against that for 1891, which was 26,050,692 lbs., value of 41,29,394 rupees.

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FRIDAY, AUGUST 27, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1898.

The dates fixed for the Society's Examinations in 1898 are Monday, March 21st, Tuesday, 22nd, Wednesday, 23rd, and Thursday, 24th.

The Programme of Examinations is now ready, Copies of the Programme, with full details, and an Appendix containing last year's questions and reports by the Examiners, can be had, price 3d., post free, on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, London, W.C.

"OWEN JONES" PRIZE.

This competition was instituted, in 1878, by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of subscriptions to that fund, upon condition of their expending the interest thereof in prizes to "Students of the School of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The following is a list of the successful candidates:—

Blagg, William F., School of Art, Chelsea—Design for wall-paper.

Dow, Helena R., School of Art, Glasgow—Design for wall-paper and frieze.

Paterson, Robert, School of Art, Glasgow—Design for a carpet.

Richter, Herbert D., School of Art, Bath—Design for wall-paper.

Smith, Bertha, School of Art, Bloomsbury—Design for wall-paper and frieze.

Wadsworth, John, School of Art, Macclesfield—Design for carpet.

The next award will be made in 1898, when six prizes will be offered for competition.

Proceedings of the Society.

HOWARD LECTURES

THE MECHANICAL PRODUCTION OF COLD.

By Prof. J. A. Ewing, M.A., F.R.S., M.Inst.C.E.

Lecture III.—Delivered February 8, 1897.

Absorption Machines.

We pass now to the consideration of absorption machines. In any machine of this type there are two substances used, which have an affinity for one another. By the direct application of heat these substances are separated from a state of union with one another. One of these is a vapour, and as it separates it is condensed at a relatively high pressure, giving up its latent heat to circulating water. Then the condensed vapour is allowed to re-evaporate, and is absorbed by the other substance as soon as it does so. During this process the other substance is kept cool, consequently re-evaporation and absorption of the vapour go on at a relatively low pressure. This low pressure is associated, in the vapour, with a low temperature. While the vapour is re-evaporating it takes up heat from bodies round it, and is effective for refrigeration. This completes the cycle, and the substances may again be separated by the agency of high temperature heat, and so on.

No mechanical work need be spent in this process, and machines of this class have no co-efficient of performance in the sense in which we have used that term. In judging of their thermo-dynamic efficiency, what we have to compare is the refrigerating effect, or heat absorbed at the lower extreme of temperature, with the high-temperature heat which is supplied in effecting the separation of one substance from the other. Calling these quantities Q_2 and Q, as before, the efficiency of the process is measured by the heat ratio

$$\frac{Q_2}{Q}.$$

Of practical machines working in this general way there are two kinds. In one kind the vapour used is water, and it is absorbed by sulphuric acid. In the other kind the vapour is ammonia, and it is absorbed by water.

WATER-VAPOUR ABSORPTION MACHINES.

When water vapour is used to effect refrigeration, the pressure at which the vapour is formed, which is the pressure due to the lower extreme of temperature, must be very low, and hence machines using water and sulphuric acid are often described as vacuum machines. The method of cooling by evaporating water in vacuo, and using sulphuric acid to absorb the vapour, was known almost from the beginning of this century. Professor Leslie, in the year 1810, or thereabouts, described a laboratory experiment, in which water was frozen by placing it in a saucer under the receiver of an àir pump from which the air had been exhausted, while there was under the same receiver another saucer containing sulphuric acid. After the air had been exhausted the vapour of water was given off freely, and was absorbed by the sulphuric acid, owing to its great affinity for water. The vapour obtained its latent heat by drawing upon the stock of heat which the water contained, and the consequence was that by the time a certain portion of the water was evaporated the remainder was so much chilled as to convert it into ice. That type of machine is essentially one of the absorption type, because the active feature in it is the absorption of water vapour by sulphuric acid. The pump which produces and maintains the vacuum is an accessory and not an essential of the machine. In practice the pump is required because there is atmospheric air which has to be got rid of in the first place, in order to let the water vapour come into free contact with the acid. When once the air is got rid of the pump might stop acting, and the performance of the machine would continue were it not for the fact that in practice there is always a certain amount of air mixed with water in solution, which continues to be given off by the water, and requires the action of the pump to be kept up. If we wish to convert such a machine into a continuously working one, with a complete cycle of operations, we must separate the water from the sulphuric acid in which it has been absorbed. That can be done by the agency of heat. Such a machine was, in fact, made in 1878 by Windhausen, and was practically employed on a somewhat large scale by the Aylesbury Dairy Company in the making of ice. It was described before the Society of Arts in 1882 by Dr. John Hopkinson. There a complete cycle of operations was used. The water to be frozen was chilled by causing a portion of it to evaporate and be absorbed by sulphuric acid. The sulphuric acid thus diluted was passed into a vessel called the concentrator, where heat was applied to drive off the water leaving strong acid ready to be used over again.

It is interesting to notice that there was an interchanger of heat between the strong and warm sulphuric acid returning to the machine after concentration, and the dilute acid on its way to the concentrator. This machine was able to freeze about 12 tons in 24 hours. A compound air-pump was used, maintaining an excellent vacuum of only one-twentieth of a pound per square inch. The ice cans in which the water was placed were, of course, air-tight, so that a vacuous atmosphere was maintained within them, and when the fresh water ran into the cans it actually froze immediately on entering by its evaporation in this vacuous atmosphere, so that when it reached the bottom of the can, it was already in a half-frozen state. The result of this was a very great rapidity of action. Six blocks of ice, weighing about 650 lbs. each, are described to have been formed in about 60 minutes after starting. Those who are familiar with the preparation of ice by modern methods are aware that it takes something like three days to produce blocks of ice of this size.

It is characteristic of this vacuum method, where the evaporation of part of the water serves to abstract heat from the rest, that the action may easily be made rapid. This in itself makes the method particularly suitable in a machine of small size. Wherever you have a slow action a small machine is placed at a great disadvantage, on account of the relatively large amount of heat which leaks into it during the long time. It is essential, in fact, in the working of a small machine, that the action should be fast, and that is, no doubt, one reason why this type of machine has survived in small sizes for domestic purposes. It is in consequence of the rapid action that this type of machine does not yield the clear blocks of ice which are obtainable by other and slower means. The bubbles of air are caught in the very act of freezing themselves from the water, and the ice is white and spongy.

The vacuum is practically necessary in all such machines, in order that the operation should go on sufficiently fast. Strictly speaking, the vacuum is not an essential feature. We might have the water evaporating into air, and the sulphuric acid then drying that air by absorbing the moisture from it. But such an operation would be intolerably slow, and in order that the machine should work properly it is essential that the air be removed to let the water have free access to the acid. The pump is kept working to exhaust any air which leaks in from outside, as well as the air that is gradually given off from solution in the water.

Previous to the development of Windhausen's machine Mr. E. Carré, in the year 1875, introduced for domestic purposes a small form of absorption machine using sulphuric acid. It consists of an air-pump and a chamber to contain the acid. Connected with the handle of the air-pump is a stirring-rod, which passes into the sulphuric acid chamber, so that the surface of the acid is continuously agitated in order to expose fresh surface of strong acid to contact with the vapour.

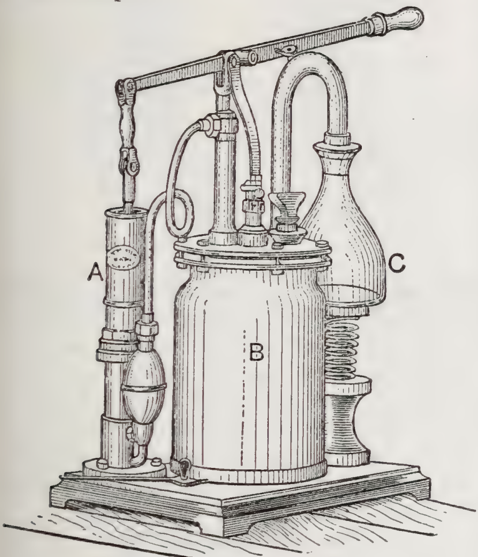

Fig. 16.

Fig. 16 shows a modified form of the small machine, sold by the Pulsometer Company. It has the specially effective air-pump of Mr. Fleuss, shown at A in the figures. The jar C, containing the water to be frozen begins to show ice on its surface in a very few minutes after we begin to work the machine. After several times of use the acid, which is kept in the container, B, becomes too dilute to be effective, and is then replaced by a fresh supply.

An important point to be noticed in regard to the efficiency of absorption machines is that in all of them the heat ratio must necessarily be less than unity. In other words, the heat Q_2, which is usefully extracted at a low temperature, is necessarily less than the high-temperature heat Q, which is applied at the other end of the machine. This is because a larger amount of heat is needed to evaporate liquid when it is in a state of solution in something else than is needed to evaporate it when it is in the pure state. Take, for instance, the sulphuric acid machine and compare the low temperature heat which is being usefully extracted by each pound of water that is evaporated with the high temperature heat which has to be supplied in order to re-evaporate that pound of water after it is mixed with sulphuric acid. To tear the molecules of water away from the acid involves the expenditure of energy over and above what is required to convert the water into vapour. In that part of the process which is effective for refrigeration—namely, the re-evaporation of the water—we have only to tear molecules of water from water and the energy absorbed is less. It is a familiar fact that when water is mixed with sulphuric acid a certain quantity of heat is produced. In order then to separate water from sulphuric acid, heat must be supplied, and when the water is separated in a state of vapour the whole heat required is more than the latent heat of the vapour.

There are not many tests to show what is the actual heat ratio reached in machines of this type. Dr. Hopkinson, in the paper to which I have referred, says that the quantity of coal burnt in the use of the Windhausen vacuum machine was about 8 per cent. of the weight of ice produced. That may be stated as in round numbers one-twelfth of a pound of coal per lb. of ice. Now, the number of units of heat which 1 lb. of coal is capable of effectively giving out by combustion is something like 12,000. The heat taken up in the manufacture of 1 lb. of ice is 142 units so far as the conversion from water at 32° into ice is concerned, but to that we must add the further quantity which is needed to lower the water from its original temperature down to the temperature at which it is frozen. Probably each pound of ice represents something like 200 units of effective refrigeration. In that case the heat ratio is the ratio of say 200 units usefully extracted to 1,200 units actually applied; in other words, it is a ratio of one-sixth. It will be seen later that if the same quantity of heat were applied to drive an engine of ordinary efficiency, which in its turn was set to drive a compression refrigerating machine of modern type, the refrigerating effect would be greater. High-temperature heat can be more efficiently applied to the production of cold in that way than in an absorption machine.

AMMONIA ABSORPTION MACHINES.

The other class of refrigerating absorption machine, which uses ammonia dissolved in water, is in much wider use than the sulphuric acid or "vacuum" machine. Its action is in general respects the same, but as ammonia has a much higher vapour pressure than water, there is no vacuum, but pressure higher than that of the atmosphere throughout. The ammonia absorption machine was invented by F. Carré about the year 1860. At first it was very crude, consisting merely of two vessels, in one of which was placed a strong solution of ammonia in water; the other in the first instance was empty, and was surrounded by cold water. The vessel containing the solution of ammonia was heated and the gas passed over under pressure into the other vessel, where it was condensed, giving up its latent heat to the water outside. A little steam passed over with it, but the main constituent of what collected in the cold vessel was liquid anhydrous ammonia. The solution of ammonia in the first vessel became more and more dilute. After this had gone on for some time, the source of heat was removed, and the vessel containing dilute solution was surrounded by cold water. The condensed ammonia in the other vessel then evaporated, being re-absorbed by the dilute solution. In re-evaporating, the ammonia exerted a refrigerating effect. By making the condenser with a hollow central space, in which a can of water was inserted, the re-evaporation of the ammonia was caused to freeze the contents of the can. The action in this small machine of Carré's was intermittent. It required that the vessel containing the ammonia solution should be alternately applied to the source of heat, and placed in cold water. Each of the two vessels discharged two separate functions; one vessel served in the first instance as the condenser of the anhydrous ammonia, then in the second instance it served as the refrigerator. Again, the other vessel served in the first instance as the generator of the anhydrous ammonia, and then in the second stage of the process it served as the absorber. Suppose, however, we have four vessels instead of two, each of the four discharging one function, and that we have a pump by which the liquid which has been in the absorber and has got the ammonia restored to it shall be pumped back into the generator. In that case we have the continuous machine, which was soon developed out of Carré's primitive apparatus. Several inventors contributed to the improvement—Mr. Reece, Mr. Stanley, Mr. Mart, and others adding features which are found in the ammonia absorption machine of the present day. A continuously-acting machine is shown diagrammatically in Fig. 17. Here we have as generator, a vessel containing a solution of ammonia; heat is applied to it by means of a coil of steam-pipe within. The ammonia gas passes over from this into another vessel, the condenser, which is a coil of pipe kept cold by a circulation of cold water. There it is condensed. Then it passes through a regulating valve into another vessel, namely, a coil forming the refrigerator, where it is evaporated. In evaporating, it picks up heat from any surrounding bodies. It is evaporated under a comparatively low pressure, and consequently at a low temperature, so that if there is, say, a circulation of brine round the refrigerator the brine may be chilled to a temperature considerably below the freezing point of water. Then the ammonia gas, having been re-evaporated, passes over into another vessel where it is absorbed by water—not by pure water, however, but by the dilute solution which is left after ammonia gas has been evaporated in the generator. In the process of generation of the ammonia gas the strong ammonia solution goes to the top on account of its lighter specific gravity, and the weaker solution goes down to the bottom, from

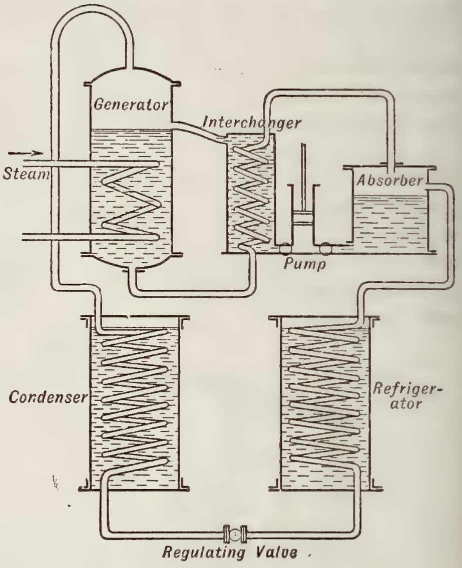

FIG. 17.

which it is allowed to pass over into the absorber, where it meets again with the ammonia gas, which has come over from the refrigerator or evaporator. After having met the gas and re-absorbed it, this liquid is pumped back to the generator where it goes in at the top. That completes the cycle of operations. In the process of absoption a large amount of heat is given out, and hence the absorber, as well as the condenser, requires to be surrounded by circulating water, or cooled in some other way.

The diagram shows between the pump and the generator another vessel, called the interchanger or economiser, which was introduced by Mart in 1870, and formed a notable improvement. In order that the absorber should act, the dilute ammonia solution in it must be comparatively cold, but that solution when it leaves the generator is hot. If it passed directly into the absorber it would have to be cooled down, and then, after the ammonia had been absorbed by it, the strong solution would have to be heated up again to the temperature of the generator. The purpose of the interchanger is to make this alternate cooling and heating of the liquid go on without much waste. The interchanger takes heat from the weak solution on its way to the absorber and gives that heat to the strong solution on its way back. Hence the strong solution reaches the generator at a temperature not very far below the temperature of the generator, and the weak solution enters the absorber at a temperature not greatly above the temperature of the absorber itself. The interchange is not complete, and, even if it were complete, the strong solution would not take up enough to raise it to the temperature of the generator, because there is a larger amount of material passing from the absorber to the generator than is passing from the generator to the absorber. Apart, however, from the loss of heat which this imperfect exchange involves, the supply of high-temperature heat to the generator must necessarily be greater than the effective refrigeration for the reason which has already been explained. In the generator we have to tear away the ammonia from the water as well as to produce the gaseous condition; whereas in the refrigerator the ammonia molecules are simply being separated from one another. Under the most favourable conditions, the heat ratio in such a machine must be considerably less than unity. It takes something like 820 or 850 thermal units to separate a pound of ammonia gas from solution with water, whereas the evaporation of 1 lb. of ammonia gas will only take up something like 500 units, and beyond that there are several sources of loss, of which the imperfection of the exchange is one.

Fig. 18 (p. 1032) gives an external view of an actual ammonia absorption machine as made by Messrs. Pontifex and Wood, whose business is now carried on by Messrs. Haslam. Such a machine as this may be seen in London at the brewery of Messrs. Meux, where it has been in use since 1876. The generator, G, consists of a cast-iron vessel with coils inside, through which steam circulates to supply heat. The vapour of ammonia when it leaves the generator is by no means in an anhydrous condition; it accordingly passes through an upright vessel, S, containing a series of trays, called an analyser, which separates the ammonia more perfectly from the water. Then it passes on to the uppermost coil of the condenser, D. This top coil is distinct from the remainder, and goes by the name of the rectifier. Its function is to purify the ammonia still further by cooling it to a temperature not low enough to liquefy the ammonia, but low enough to condense the steam which is mixed with it. The water condensed in the rectifier is caught in a series of pockets and is returned into the upper part of the analyser. The ammonia gas continues its course down through the main coils of the condenser where it is liquefied. It next passes through a regulating valve to the cooler or refrigerator, R, where it is re-evaporated and through which the brine or other substance to be covered circulates in pipes. It then goes to the absorber, A, where it meets with and is absorbed by a current of weak liquid from the generator, which has passed meanwhile through the economiser or interchanger, E. Finally, the strong solution formed in the absorber goes back to the analyser, where it drops down over a series of trays, allowing the gas to being extracted from it, even before it reaches the generator proper. The pump, P, is for pump- the strong liquid back from the absorber to the generator through the interchanger and analyser. The absorption machine at Messrs. Meux's is as large as these machines are practically made in this country. The ordinary mode of rating refrigerating machines is to state the number of tons of ice they can produce in 24 hours, whether they are actually used for the production of ice or for other purposes. This machine is employed in cooling the wort, and is rated as a 24-ton machine. It has a very good record during its long term of service, and a visit to it leaves the impression that for certain purposes there is much to be said for this comparatively simple type of machine. It cannot pretend to the same efficiency as that which is reached with a good compression machine, nor claim to be compact, but it has the advantage of few working parts, and has, apparently, very little liability to derangement. It commends itself in cases where it may be desirable to have little need of attention on the part of a skilled fitter. Machines of this class are made to a considerable extent in America. The firm of Sulzer-Vogt, for instance, supply machines having the same organic parts, but differing considerably in points of mechanical construction from the machine of Fig. 18. Their generator is a long vertical vessel, with 3 or more horizontal projections near the bottom of it, in which the actual generation occurs. It is not a cast-iron vessel, as in the example of Fig. 18 but is built up of wrought iron or steel plates, and the interchanger consists of two concentric pipes, the inner pipe forming one channel, and the annular space between the two forming the other. No form of heat interchanger is more effective for its purpose than that. The Sulzer-Vogt machine is used at Louisville for the working of a very interesting system of distributed refrigeration, which is also found in some other American towns. Cold is, so to speak, laid on from a central station, like gas and electricity, to the houses and shops of the consumers scattered through the town. What is actually distributed is liquid ammonia; it is sent out under pressure along mains buried in the streets, and is admitted as it is wanted to refrigerating coils on the premises of each consumer, who obtains any amount of refrigeration he pleases by regulating the amount of ammonia admitted to his evaporating coils. There are two mains, in one of which liquid ammonia is supplied under pressure, while in the other gaseous ammonia is taken back to the generating station. Each consumer's coil is simply a pipe forming what would be called in electricity a shunt between the two, and each draws off ammonia through a regulating valve to his own coil without interfering with his neighbours. The absorption machine is claimed, I think justly, to have the advantage for such central station work, that, however fast or however slow the ammonia vapour comes back to the central station, it can readily be taken up by absorption in water, whereas if a compression machine were used, its speed of working would have to vary in accordance with the varying demand for refrigeration. An absorption

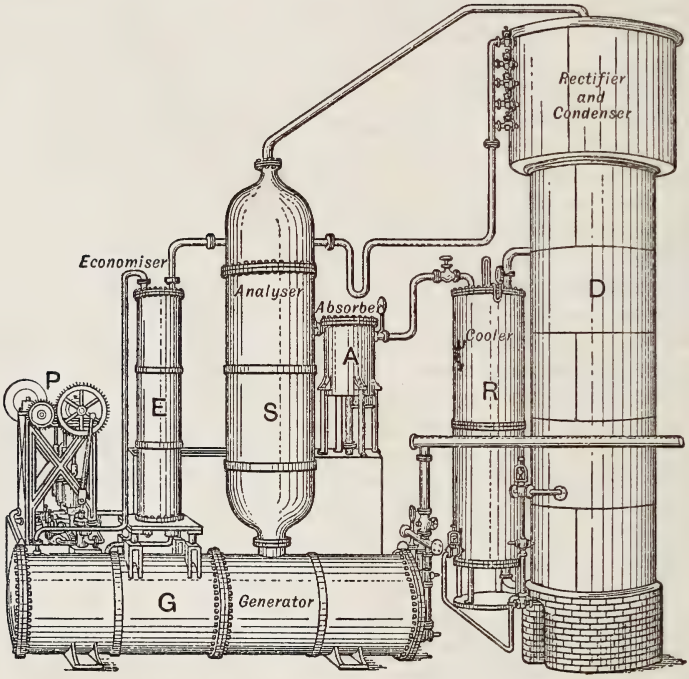

FIG. 18.

machine allows the operation at the central station to go on in a tolerably uniform way without much reference to the varying rates at which consumption occurs throughout the area of supply.

I pointed out that the heat ratio in all such machines is necessarily less than unity, something like 0·6 from the theoretical point of view, but you must not suppose that any actual absorption machine reaches, or nearly reaches, even this moderate figure. The most complete authentic data with which I am acquainted as to the performance of a machine of the absorption type are supplied by Professor Denton in a paper published in 1888 by the American Society of Civil Engineers. He tested a refrigerating machine of the Pontifex type, employed to cool brine from 21° Fahr. to 16° Fahr., and supplied with cooling water at 54½° Fahr. He found that each pound of steam supplied to the machine gave up 932 thermal units, and effected an amount of refrigeration measured by 243 thermal units; in other words, the heat ratio—namely, the ratio of the effective refrigeration to the heat supplied was $\frac{243}{932}$ or 0·26. In round numbers, this machine did an amount of refrigeration equal to one-quarter of the heat which was supplied to it in the steam. The steam which was reckoned in this test included not only the steam supplied to the generator, but also that required to drive the pump. It is interesting to compare this figure, ¼, with the theoretical efficiency of an ideally perfect refrigerating machine. Taking the limits of temperature which were used in Professor Denton's test, an ideally perfect refrigerating machine—namely, a combination of reversible heat-engine with reversible heat-pump—would give a heat ratio of 2·25 instead of 0·26. This shows how far the ammonia absorption machine comes from being a reversible engine in the thermo-dynamic sense.

VAPOUR-COMPRESSION MACHINES.

I pass on to speak in some detail about the process of refrigeration which is now far and away the most important process of all—the vapour - compression process. Air-machines and ammonia absorption machines find a limited amount of use; but the great bulk of the work of refrigeration is done by machines which act by the mechanical compression of a condensible vapour. The scientific and historical interest of other methods have led us to spend a considerable time upon them, but in point of commercial importance they take a very secondary place. Moreover, the vapour-compression process is the most efficient of all. It allows a co-efficient of performance to be reached in practice which makes a very respectable approach to the thermo-dynamic ideal.

I explained in the first lecture, in speaking of Fig. 6, how a liquid with its vapour could be carried through a perfect refrigerating cycle, forming a reversal in all respects of the cycle of Carnot. This would necessitate the use of an expansion cylinder as well as a compression cylinder, the function of the expansion cylinder being to allow the liquid from the condenser to cool adiabatically to the temperature of the refrigerator. In practice the expansion cylinder would be very small—much smaller than appears from Fig. 6, for that diagram was drawn to represent a machine using air. Expansion would take place from the volume of the liquid up to a volume in which enough of the liquid is evaporated to reduce the temperature of what is left down to the temperature of the refrigerator. That is generally quite a small proportion of the whole—something like one-tenth or, at the most, one-quarter. But in all actual machines which employ a vapour the expansion cylinder is omitted, and the organs are those shown diagrammatically in Fig. 19.

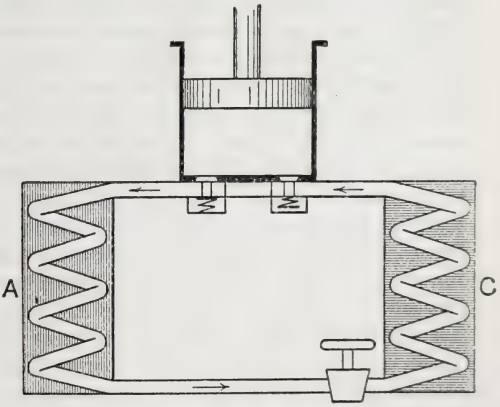

FIG. 19.

There the vapour from the refrigerator, C, is compressed by the piston into the condenser, A, where it is liquefied; but it returns from A to C through a simple regulating throttle-valve instead of through an expansion cylinder. In passing through the throttle-valve, part of it becomes gaseous, so that when it reaches C it consists of a mixture of liquid and vapour, but the liquid part preponderates. It continues to evaporate in C, and, in doing so, takes up heat from the surrounding brine or whatever is there to be cooled.

Any liquid which can be alternately liquefied or evaporated, or, in other words, any liquid whatsoever would serve as a possible working substance in such machines. Liquids which have been used are water, sulphuric ether, sulphurous acid, ammonia, and carbonic acid. A machine employing water for its working substance in this way must be a vacuum machine on account of the low vapour-pressure of water, but its action is, of course, different from that of the sulphuric acid vacuum machine already described. Here the working substance undergoes no solution nor chemical change. The vapour as it is formed is disposed of by the pump instead of by absorption in acid. Windhausen's machine, to which I have referred, was sometimes used without the sulphuric acid, and in that case it formed an example of the class of machines we are now dealing with. There was only this difference that the water vapour discharged by the air-pump did not complete a cycle by returning to the refrigerator, but other water took its place. Another machine of the same class was put on the market some years ago by Messrs. Southby and Blyth, where water was the working substance, and a vacuum was maintained by pumping without the use of sulphuric acid. The enormous volume of the vapour which has to pass through the pump in such machines is a serious practical objection to their use. It makes the machine bulky and the frictional losses relatively large. It may occur to you that there is another disadvantage in the use of water—namely, that if we attempt to evaporate water at a temperature below 32° Fahr. it will freeze. That, however, can be got over when lower temperatures are wanted by using brine instead of water for the working substance. The working cycle remains practically the same, and the lower limit of temperature may then be much reduced. But the vapour becomes bulkier than ever; the machine is inconvenient and inefficient. The work spent in overcoming the friction of the piston packing tends to form a large part of the whole work that has to be expended. Remember that any heat developed in the compressor by mechanical friction not only adds to the amount of work to be done in driving the machine, but takes away from the effective refrigeration which the substance should produce.

International Congress on Technical Education.

FRIDAY, 18TH JUNE.

SECTION B.—*(continued)*.

Major-General Sir OWEN TUDOR BURNE, G.C.I.E., K.C.S.I., in the chair.

TECHNICAL EDUCATION IN NEW SOUTH WALES.

BY SIR WILLIAM C. WINDEYER, M.A., LL.D.

Ex-Chancellor of the University of Sydney; and Senior Puisne Judge of the Supreme Court of New South Wales.

The movement in favour of technical education in England which resulted from the great exhibition of 1851, demonstrating as it did to the English people the necessity of giving its skilled artisans and handicraftsmen such an education as would enable them to compete in manufacturing skill with workers of continental countries where technical education had already made considerable progress, had sufficient impetus to affect even the far-off colonies of Australia, and after the usual amount of discussion necessary for the education of the public mind previous to the introduction of any novelty in the scheme of national life, steps were taken for giving the working-classes of New South Wales the means of obtaining technical instruction. As is so often the case in the initiation of systems which afterwards become matters of national concern, the foundation of a national system of technical education in New South Wales, was laid by a few gentlemen working unofficially. To the untiring energy of Mr. Edward Dowling, a printer in the Government printing office and a member of the Committee of the Sydney Mechanic School of Arts, a literary institution of which I had at that time the honour of being president, is chiefly due the honour of initiating the system of technical education now publicly maintained in the colony.

In 1873 this committee succeeded in establishing, in connection with their institution, a technical college which gave instruction in the leading branches of mechanical art. This college proved so successful, that in 1878 the committee induced the Government of that day to grant a sum of £2,000 a year towards carrying on the working of the college, and towards its more perfect equipment, and for five years it was managed by the Committee of the Mechanics' School of Arts. By this time, however, the operations of the college had become so extensive, that their control it was felt, both by the Government and by the committee, would be better maintained by a permanent Board than by one of so shifting a character as the committee of a popular institution, and in 1883, with the concurrence of the committee, a Board was appointed by the Government which took over the management of the college, which from that time became a State institution now recognised as an important factor in our system of public instruction. The college continued to be managed by the Board till 1889, when in consequence of the growth of the college, its extension to country districts and the large expenditure of public money involved, it was thought expedient to dissolve the Board and to place the whole system of technical education under the direct supervision and control of the Minister of Public Instruction. This was accordingly done, and technical education is now firmly established as a prominent branch of our State system of education, for the maintenance and extension of which the Parliament of New South Wales in a spirit of wise liberality has always been ready to vote considerable sums.

The old college premises in connection with the school of arts having become too small for the rapidly increasing number of students, the Government secured a site in the outskirts of the city of Sydney, very happily chosen from its proximity to the locality chiefly inhabited by the artisan class, and upon it erected, under the auspices of Mr. Carruthers, the then Minister for Public Instruction, a splendid pile of college buildings which would be regarded as imposing even in London.

The buildings include an admirable museum suited to the requirements of the institution and all necessary workshops and lecture-rooms.

As the report of the Minister of Public Instruction for the year 1896 has not yet reached England, I am unable to give authoritatively the number of students attending the college last year, but the number of students enrolled in the year 1895—and it is to the year 1895 that my figures refer—was 3,458. In addition to the students attending the college, the students attending nine suburban classes number 550, students attending nineteen country classes 2,252, and students attending classes connected with public schools 811, making a total enrolment of 7,051 in 1895. From a newspaper report of a speech made by the Minister of Public Instruction last April it would appear that the increase in the number of students last year was 311 throughout the colony. Deducting from the total enrolment the cases where students joined more than one class, the number of individual students was 5,458, an increase of 530 upon the number of individual students in 1894, and the average weekly attendance in all classes being 3,492.

The total number of classes in operation was distributed as shewn below:—

	Under Salaried Teachers.	Teachers paid fees only.	Total.
Sydney Technical College......	70	12	82
Suburban Classes..................	9	11	20
Classes in Country Towns......	76	10	86
Classes from Public Schools...	10	—	10

The classes in the commercial group are not regarded as an integral part of the system of technical education, and the teachers are not paid by salary but derive their remuneration solely from the fees paid by their pupils. The subjects are shorthand, book-keeping, caligraphy, and correspondence, &c. The enrolments for these subjects during 1895 were 700, but in many cases students had entered for several of the classes.

The students examined at the close of the year numbered 2,651, of whom 1,788 or 67·4 per cent. were successful; in 1894 there were 2,457 examined, of whom 1,644 or 66·9 per cent. passed. Besides the ordinary examinations held by the college, technological examinations of the City and Guilds of London Institute conducted throughout the empire, are annually held in Sydney under the management of the college, and the success of Sydney students from year to year in those examinations has ever since their establishment been a matter of congratulation amongst colonists, who are pleased to find that our best students hold their own in this imperial inquest into the progress of technical education throughout Her Majesty's dominions.

From a return kindly furnished me by Sir Philip Magnus, of the City and Guilds of London Institute, it appears that during the ten years that have elapsed since the examinations were first held in Sydney, 664 candidates presented themselves for examination, the subjects selected by the candidates being chiefly:—

Electric Lighting.
Plumbers' Work.
Mechanical Engineering.
Lithography.
Mine Surveying.
Oils and Fats.
Brickwork and Masonry.
Milling (Flour Manufacture).
Painters' and Decorators' Work.
Carpentry and Joinery.

Gas Manufacture.
Iron and Steel.
Photography.
Telegraphy & Telephony.
Raising and Preparation of Ores.
Typography.
Carriage Building.

At the examinations held in Sydney, in April, 1896, 24 candidates presented themselves, and 17 obtained certificates, according to the Report of the Minister of Public Instruction for 1896. Two candidates in plumbing, and one in iron and steel manufacture, passed in highest class honours. The teaching staff comprises 82 persons, viz., 11 lecturers in charge of departments, 5 resident masters in charge of branch schools, 38 teachers, 15 assistant-teachers, and 19 teachers in charge of classes remunerated by pupils' fees only.

The technological museum of the college was during 1895 visited by 118,967 people, and the number of visitors to the technical museums which have been established in our four largest country towns, Newcastle, Goulbourn, Bathurst, and Maitland, amounted to 130,683, making a total, out of a population of 1,300,000, of 249,650 persons visiting museums entirely devoted to the purposes of technical education, a striking proof of the popularity of these institutions, upon the benefit of which in country districts, where new discoveries in the mineral wealth of the colony may be made by persons whose intelligence and curiosity have been stimulated by the sight of natural specimens, it is not necessary to enlarge. When as a judge visiting circuit towns in which such museums have been established, I have had much pleasure in listening to the accounts given by their curators, of the stimulus to inquiry which is thus given amongst our youthful rural population and of the constant bringing of mineral and other specimens to the museum for the purpose of examination as to their character and value. In addition to the ordinary work of the museum, a large amount of original work in the way of scientific research has been done both in the mineral and vegetable kingdoms by the members of the scientific staff of the museum, headed by Mr. Maiden, its indefatigable superintendent, to whose valuable and elaborate report on the technical college and its branches I am much indebted for the information which I have been able to give the Congress.

The total expenditure on technological education during 1895, including £3,838 1s. 7d. spent on the technological museums amounted to £24,238 16s. 8d. Of this sum £20,296 7s. 11d. was a Parliamentary grant, and £3,94 28s. 9d. represents the fees paid by students. These figures are some evidence that a colony of 1,300,000 people, which in 1895 devoted £628,500 to the purposes of public-school education out of a revenue of £9,000,000 sterling, is also not remiss in making provision for the training of its craftsmen.

In addition to the prizes given by the Government, which have been found a great incentive to students for the methodical and continued prosecution of their studies throughout the year, in all our branch schools, in the suburbs and in the country districts, so much interest is shown in the work that many prizes, some of them of considerable value, are given by local residents, a pleasing feature in this regard being gifts from former students in recognition of success in life, gratefully attributed in a large degree to instruction received at the technical college,. As year after year rolls by, we trust that this coin of kindly fellow-feeling for the struggling student will be so freely passed on by those who attain wealth by skill and industry, and who have themselves been benefited by the generosity of former students, grateful to their industrial nursing mother, that in course of time private donations will altogether relieve the State from the the necessity of providing a special prize fund. Splendid in its munificence, I must not omit to mention in this connection a gift of £50,000 to the University of Sydney for the founding of a school of engineering, made by the Whitworth of Australia in his encouragement of mechanical science—Mr. Peter Russell, now of London, formerly of Sydney—where his enterprise laid the foundation of the wealth which he has so nobly used in promoting the scientific study of a business in which his extensive works for so many years gave employment to hundreds of workmen. It cannot be doubted that the founding of this school, which has at its head a Whitworth scholar as Professor, and which is already turning out engineers who are at once finding employment in our mines and public works, will prove a great incentive to the scientific prosecution of their studies by the most intelligent of our students in the technological college, and efforts are being made, which I trust will prove successful, to bring about co-operative teaching between the technical college in its practical engineering branch and the university, as giving the highest scientific instruction in its Peter Russell School of Engineering.

The subjects taught in the college and technical schools are, with the attending number of students in each class, shown in the following Table:—

TECHNICAL COLLEGE AND BRANCHES, 1895.

CLASSES IN TECHNICAL SCHOOLS.	ENROLMENT. Metropolitan.	ENROLMENT. Country.	ENROLMENT. Total.
Classes fully recognised.			
Geology	59	80	139
Metallurgy	—	5	5
Mineralogy	45	14	59
Mine Surveying	—	15	15
Coal-mining	—	83	83
Mining	37	—	37
Architecture	39	26	65
Building construction	15	21	36
Stone carving and masonry	9	—	9
Bricklaying	12	—	12
Carpentry, joinery, lathe, &c.	133	163	296
Sign-writing & Art decoration	60	—	60
House painting	33	—	33
Plumbing, practical	112	47	256
,, sanitary	97		
Engineering, sanitary	26	—	26
,, electrical	87	—	87
,, steam and steam engine	—	16	16
Fitting and turning	115	—	115
Pattern-making	26	—	26
Iron-founding	11	—	11
Boiler-making	30	14	44
Blacksmithing	23	—	23
Farriery	20	—	20
Veterinary science	32	—	32
Chemistry, practical	42	12	54
,, theoretical	36	218	254
,, pharmaceutical	28	—	28
Pharmacy	30	—	30
Materia Medica	16	—	16
Dispensing	14	—	14
Physics	44	236	280
Botany	—	17	17
Agriculture (afternoon)	21	99	293
,, elementary	121		
,, advanced	52		
Sheep and wool	60	—	60
Wool-sorting	115	—	115
Mathematics	—	94	94
Applied mechanics	47	24	71
Book-keeping	—	66	66
Art Classes—			
Drawing	—	952	952
Freehand Drawing	313	—	313
Model ,,	175	—	175
Perspective ,,	50	—	50
Antique ,,	44	—	44
Life ,,	35	—	35
Still Life ,,	26	—	26
Plant ,,	14	—	14
Mechanical ,,	75	103	178
Geometrical ,,	56	—	56
China painting	14	—	14
Modelling in clay	73	—	73
Lithography	68	—	68
Cookery, plain	103	—	103
,, advanced	31	—	31
Fruit preserving	23	—	23
Starching and Ironing	35	—	35
Total	2,782	2,305	5,087
Classes (on Fees only).			
Mathematics	108	5	113
Slide Rule	18	7	25
Dressdrafting	88	84	261
Dresscutting	53		
Dressmaking	36		
Total	303	96	399
Classes sanctioned temporarily			
Caligraphy	70	28	98
Book-keeping	87	22	109
Phonography	216	351	567
Total	373	401	774
TOTAL	3,458	2,802	6,260
CLASSES IN STATE SCHOOLS.			
Manual training	461	165	626
Physics	71	—	71
Art Drawing	—	114	114
TOTAL	532	279	811
TOTAL, ALL SCHOOLS	3,990	3,081	7,071

Besides the instruction given in the Technical Collge in Sydney, technical schools have been established at our chief population centres in the country towns, in the largest of which —Goulburn, Bathurst, Newcastle, and Maitland—are the technical museums to which I have already alluded. In these schools 86 classes are in operation, the subjects in which instruction is given being almost the same as those in the Central College at Sydney, with the exception of the engineering trades, which require workshops and machinery of so expensive a character that the small number of students in our country towns would hardly justify the outlay necessary for their erection. The enrolments in these country classes, however, in other subjects, amounting to 2,252, show that these country schools are doing good work in our provincial centres. In addition to country and suburban schools in the neighbourhood of Sydney, technical classes have been established in connecton with our primary public schools, which are of the same character as the Board schools of England. In these schools manual training is carried on upon a uniform system of instruction, with a progressive course of practical exercises extending over three years, the pupils being taught under the Sloyd (Swedish), London School Board, and Pensylvanian College systems. It is believed by competent judges, that the exercises through which pupils of our own system are required to pass, will compare very favourably with either of the other systems above referred to.

Considerable economy is exercised by having in the country districts one central workshop to accomodate the pupils of the various schools, instead of a small workshop at each school. Each school would otherwise require separate benches, a separate stock of timber, and of principle tools, and much of the instructor's time would be occupied in going from school to school to give the lessons.

Under the present system the pupils are taken in detachments from their respective schools to the local technical colleges and receive instruction, the instructor's time being thereby fully taken up. The pupils are taught the use of tools by instructors connected with the technical college and branches. The course consists of carpentery, joinery, and other selected handicrafts. Examinations are held annually and certificates issued to successful students. Those who take interest in the cause of public education will, I think, agree with me that the importance of associating instruction in manual arts with the development of mental knowledge can not be over-estimated. It seems to me, the longer I watch the results of our system of general public instruction, to be a much-needed corrective of a growing tendency, on the part of the young drawn from our working-classes, to despise the pursuit of the mechanical arts, skill and pre-eminence in which shewn by their parents, has so largely contributed to build up the wealth and power of the English race throughout the world. We hope in our colony of New South Wales that this effort to associate in our schools manual training with book-learning will help to inspire our citizens of the coming Commonwealth of Australia with a proper appreciation of the dignity of all labour, and with a fuller recognition of the fact that a higher order of intellectual power is required to make a skilled handicraftsman, than to produce a clerk, only fit for the work of adding up endless columns of figures or copying letters. This proper appreciation of the worth of mechanical skill is quite consistent with the duty of affording those bright intellectual spirits, who have a real calling for the highest work in the hierarchy of labour, the opportunity of rising to whatever sphere of intellectual activity their energy and ability entitle them to aspire.

Happily no disposition is shown by the girls in our public schools to ignore the importance of obtaining technical instruction in those subjects which so materially contribute to the comfort of a home and to the promotion of thrift. In 1895, 13,000 girls in the metropolitan district alone, presented themselves for examination in needlework, the ladies of our local boards giving stimulus and encouragement to this subject by offering prizes and rewards for superior excellence. The directress of needlework reports that the introduction of specimen pieces with coloured cottons in the lower classes has produced good results, whilst the qualities of independence and self-reliance are inculcated among pupils of the upper classes by teaching them to cut out and set their own work; special attention to dressmaking being directed and made general in all schools where practicable. Pupils are taught to take correct measurements from any person, no matter what may be the figure, and to draft the pattern on paper to the measurements taken, the proper method of making alterations being also shewn. It is a pleasing feature in our public schools, testifying to the well-to-do condition of our working-classes that even when there is a noticeable depression in industrial pursuits it is rare to find pupils unprovided with sewing materials according to their attainments. Starching and ironing classes have also proved very popular amongst the girls. Cooking classes are carried on in the chief metropolitan and country schools, 1,300 girls attending three classes in 1895, two lessons a week being given, one in demonstration and one in practice.

DISTRIBUTION OF STUDENTS.

Coming to the consideration of the distribution of students in our technicnl college and its branches, it is noticeable that there are more students enrolled in the art group than in any other, there being no less than 1,800 entries in this section, though this of course does not mean individuals, as in drawing several subjects are interdependent on each other, and naturally one student will take up several subjects. Students taking up freehand or model drawing for instance are recommended to enter also for geometrical and perspective drawing; those entering for still life are required to have passed in freehand and model drawing, or to be studying those subjects concurrently with still life.

The art group includes the following subjects:—Freehand and model drawing, geometrical and perspective drawing, modelling ornament, drawing and modelling from the antique, plant drawing, still-life, drawing from life, and china-painting, which should be of use in enabling local students to apply their art knowledge to the decoration of pottery, the subjects chosen being Australian wherever considered desirable.

In this connection, it is interesting to note that, owing to the enthusiastic efforts of one of our early art masters, Mr. Henry, to establish a distinctive National School of Art for Australia by the introduction of our Australian flora and fauna into decorative art, our architecture and house decoration already show the result of teaching our stone-carvers, painters, and others how to use our national objects of beauty in decorative art; and I have little doubt that in time to come the stenocarpus, waratah, and lyre bird will be recognised as distinctly characteristic of Australian as the acanthus and spear-head are of Greek art.

Over 500 students enrolled in 1894 for what might be called the agricultural and pastoral group of subjects, viz., agriculture, wool-classing, wool-sorting, veterinary science, and the principles of farriery. This is a very important section of our work, and one that should be productive of much good to the colony at large. There are few persons in Australia who at some time or other would not have been benefited by even an elementary knowledge of some of the subjects dealt with in these classes. In addition to the regular class-work in agriculture, field lessons are given. By means of these field lessons practical instruction is afforded in soil formation and treatment, native vegetation and grasses, live stock on the farm, tree planting, budding, pruning, vegetable gardening, irrigation, poultry, bee-keeping, &c., and thus, so far, we have overcome the most serious defect in the college system—that is, lack of instruction in manual work.

In addition to the work of the college and branch classes, lectures are also given by request in country districts, as well as advice concerning many diseases of plants, &c.

A special class for the analysis of milk, butter, salt, and other matters of dairying importance is also carried on. Men from the milk and dairying companies attend, in addition to the ordinary students, who, with the others, quickly master the more technical details so necessary for the work of the present day.

As a visitor to England I have been somewhat surprised at the absence amongst English farmers of that co-operative organisation in the dairying industry which is so conspicuous amongst the farmers of New South Wales, and which enabled the Australian Colonies in 1896 to send you at a profit to themselves, 17,000 tons of butter, whilst the dairying industry of England seems to me to be lanquishing for want of the diffusion of that scientific teaching of the best methods of producing a uniform quality of butter which has given Denmark and other countries so large a control of the English market.

Besides the instruction in farming pursuits given by the Technical College, further provision has been made for the teaching of students in agriculture by the establishment of an Agricultural College, where a two-years' course in practical farm work is given, which the student may follow up by a further course upon an experimental farm where the work is carried on upon a most extended scale. The course of study in the Agricultural College comprises the principles of agriculture, chemistry, botany, vegetable pathology (including the use of the microscope), entomology, geology, veterinary science and practice, mensuration, mechanics, elements of surveying, ambulance instruction, farm book-keeping, besides all kinds of practical work on the farm, instructions in field operations, the use of farm implements and machinery, all dairy operations, necessary carpentry and engineering required on a large farm, the management of stock, bees, and poultry, viticulture, wine-making, and all branches of gardening and orchard work.

Trade and professional subjects are much in demand by students in the city and suburbs and in some country centres. About 1,500 students are enrolled in the classes in this section. The subjects include carpentry, building construction, architectural history and drawing, electrical engineeering, home-painting, graining and marbling, sign-writing, art decoration, mining, mechanical drawing, pattern-making, iron-founding, fitting and turning, boiler-making, black smithing, plumbing, sanitary engineering, pharmacy, lithograpy, coal mining, and slide-rule.

In subjects purely scientific there were last year 1,085 enrolments for such classes as chemistry, geology, physics, mineralogy, mathematics, &c.

In the domestic group are included classes in cookery, domestic economy, scientific dress-making, starching and ironing. There were nearly 400 enrolments in this section which is attended exclusively by women. These are not, however, the only classes in which there are female students, as they are to be found studying in all the art classes, and in those for lithography, photography, agriculture, geology, chemistry, physics, architectural drawing, &c., as well as in the commercial classes conducted for fees only, viz., shorthand, book-keeping, mathematics.

The interest taken in the treatment of sheep and wool—as might naturally be expected in a country which contains nearly one-fourth of the sheep of the world, and sends to England more wool than does all the rest of the world—is very considerable, the classes in these subjects being so crowded that many applications for admission have to be refused. The work is practical, and students, according to their capacity, work at the various branches of the trade, from opening, skirting, rolling and classing all kinds of fleeces used in New South Wales. The advanced students are taught wool-sorting; wool-scouring also receives great attention, pupils taking turn two days per week in batches at this work.

Many students avail themselves of the opportunities of attending shows, where the lecturer acts as judge and practical instruction in judging is given. Sheep sales are also used for sheep instruction. There are many applications from wool-growers for young men to work in their sheds at shearing time, from skirting and rolling, to piece sorting and classing. Woolgrowers are evidently finding out the value of these trained students, as the demand for their services is increasing, employers stating that they are more reliable and faster than the ordinary hands. Wool-brokers are also engaging wool-classers from amongst our students.

The facts and figures which, from such material as I had at my command, I have been able to give with reference to the state of technical education in New South Wales, will, I trust, enable the section of the English people taking an interest in the subject and in colonial affairs to understand to some extent the amount of work done by their English brethren in the mother colony of Australia, in a department of education upon which so largely depends the success of the British people in the industrial competition of the world.

TECHNICAL EDUCATION IN VICTORIA.

By H. F. Eaton.

Let me preface this paper by saying for the information of such of my hearers, if any there be, who are unaware of the fact, that Victoria is the smallest of the five self-governing colonies into which the continent of Australia is divided. The area of Australia is estimated to contain 2,944,628 square miles, of which Victoria possesses 87,884, or 56,245,760 acres; Great Britain, exclusive of the islands of the British seas, contains 88,094 square miles and is therefore somewhat larger than Victoria. The extreme length from east to west is about 420, and its greatest breadth about 250 and its extent of coast line nearly 600 geographical miles. Still, although the smallest in extent, Victoria was until recently the most populous, and was deemed to be the richest. In population, it is now topped by New South Wales, the latest figures being 1,174,888, or 122,752 below the number (1,297,640) given for New South Wales.

Victoria has produced more gold than all the rest of the Australian Colonies. Up to the end of 1896, she produced 60,991,408 ounces, valued at £243,865,632, and the total yield for the year ended the 31st December, 1896, was 805,087 ozs. Besides the wealth of the precious metal, Victoria possesses in the fertility of her soil still greater sources of wealth. Victoria has been called the "Cabbage Garden" of Australia probably because she is small, and does export cabbages and other vegetables to her neighbours. Before its separation in 1851 from New South Wales, the province figured on the map as "Australia Felix," and a residence of forty years warrants me in saying Victoria still deserves to be so called.

An experimental farm, established in 1858, near Melbourne, was the earliest provision for any kind of technical instruction in Victoria. The first report of the director on the 29th November, 1859, states that "there is now provided within an easy distance of Melbourne a farm containing every useful agricultural product of Great Britain, in addition to many others, such as the vine, natives of more southern latitudes, and from its proximity to the university and other advantages an excellent opportunity is afforded by its conversion into a training establishment, of imparting an agricultural, in conjunction with a literary, education to persons desirous of following farming pursuits in this colony." But the offered opportunities were not availed of, the expectations of the director proved too sanguine, the farm became controlled by a committee of the Board of Agriculture, which led to the director's retirement, though a committee of the Legislative Assembly, 4th July, 1862, found that "at the time the director was superseded the farm was being carried on in a manner calculated to promote the interests of agriculture generally, had sufficient time been afforded to show results." For several years subsequently the farm was worked under lease, conditioned as to experimental cultivation, and some interesting annual reports were furnished by the lessee. In 1867 he relates experiments with a steam plough and cultivator, describing them as highly satisfactory. He discouraged too great reliance on grain, extolled grass, and recommended greater attention to wool, tallow, butter, bacon, and cheese—all now, especially butter, being important exports from Victoria, though of the products mentioned the two former only were exported thirty years ago, when the report quoted was made.* During the ten years' working of the experimental and model farm—1859 to 1868—besides the land, the Government contributed £13,827 towards the expenses of its management, showing a laudable liberality in endeavouring to provide technical and experimental instruction to agriculturists.

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* According to Mr. Sinclair, Superintendent in London of exports for the Victorian Government, the quantity of butter exported from Victoria in the year 1894-5 was 25,986,447 lbs., and of cheese 1,000,000 lbs.

The next step in the direction of promoting technical education, was the appointment of a Royal Commission in 1868, upon a motion in the Legislative Assembly, by Mr. S. H. Bindon (afterwards Minister of Justice), "That in the opinion of this House, it is desirable that a Board be appointed to provide, by lectures and otherwise, technological and industrial instruction among the working classes." Mr. Bindon was chairman of the Commission, and amongst its members were the Rev. Dr. Bleasdale, who was a Catholic priest of scientific reputation, and Professor (now Sir) Frederick McCoy, D.Sc. of Cambridge. A report was issued in February, 1869, which is reproduced here to show how thoroughly the Commissioners realised the importance of the work, and how well they, at that early stage, laid the foundation of that system of technical instruction which has done, and is still doing, so much in the colony:—

"We consider that lectures on industrial instruction should be periodically delivered in Melbourne and other localities throughout the country, for the purpose of diffusing useful information on the most recent and approved scientific methods of conducting the practical details of such arts and manufactures as are at present or may hereafter be carried on with profit in Victoria, and we are engaged in making arrangements for the delivery of such lectures. Having regard to the special occupations and reqnirements of the people in different localities, we think the follow- classification suggests subjects which deserve primary and early consideration:—

"I.—ANIMAL PRODUCTS

"considered in relation to manufactures with the newest chemical and mechanical appliances in relation thereto. Under this head may be mentioned the tanning and preparation of leather, the preservation of meats for exportation, the manufacture of glue, soap, candles, the preparation of wool, silk, &c.

"II.—VEGETABLE PRODUCTS

"and their manufacturing uses, with the chemistry and machinery incidental thereto; for example the preparation of fibre, the manufacture of paper, wine-making—the theory and management of fermentation, distillation, brewing, &c., the extraction of dyes, oils and perfumes, &c.

"III.—MINING AND MINERAL PRODUCTS.

"(*a*). Gold, its extraction from alluvium, quartz, and pyrites, making known the most recent European and American methods of washing, &c., and seizing; the construction of machinery, and the most recent improvements; the chemistry incidental to testing, smelting, amalgamating and assaying, &c.

"(*b*). Coal, Shale, and Mineral Oils, with reference to their existence in this country, and economic value, &c.

"(*c*). Sulphur, in connection with the manufacture of gunpowder, sulphuric acid, &c.

"(*d*). Clay and Sand: their uses in building, terra-cotta, pottery, glass-making, &c.

"(*e*). Building Stones, &c.: the several varieties in the country; the supply, their quality, analysis, &c.

"IV.—MECHANICS AND MACHINERY APPLIED AS HYDRAULICS.

"In relation to storage of water, irrigation, the construction of pumps, the sinking of wells, dams, and reservoirs, &c.

"V.—SCHOOL OF DESIGN.

"Considering how intimately connected the arts of drawing and designing are with manufactures and machinery, and that the mechanics and artisans of this country are without that assistance afforded both by the manufacturing capitalists and governments of Europe, we are of opinion—

"(*a*). That a teacher of decorative drawing should be engaged to give instruction to artisans and others, specially with reference to ornamental and decorative work as used in the arts and manufactures;

"(*b*). And also that a teacher of mechanical drawing, with suitable appliances, be appointed to give instruction to artisans and others in architectural and engineering drawing and plan-making.

"We propose to consult the representatives of the several trades for the purpose of ascertaining how far such a project as the foregoing may be supported by the mechanical classes, and, from some information already received, we believe that the result will be satisfactory.

"VI.—TECHNOLOGICAL AND INDUSTRIAL MUSEUM.

"We believe that an institution of this sort devoted to industry and art, is essential, if it is expected that the mechanics or artisans here are to compete with those in England—an institution where models of machinery, of new inventions, and improvements could be examined, where specifications of patents could be compared with the models explanatory of same, where samples of materials—mineral, vegetable, and animal—used in manufactures could be arranged for permanent exhibition, and continually employed in illustrating the details of such manufactures; and thus the appliances of science to the material, to the processes, and machinery of manufacture exemplified in such a manner as would greatly contribute to industrial knowledge and the increase of our producing and manufacturing power. We propose, so far as we are able, to collect samples and specimens for this purpose.

"We may remark that attention has been called to a Parliamentary paper, printed by order of the House of Commons, 2nd November, 1867, being a letter from Bernhard Samuelson, Esq., M.P., on technical education in various countries abroad, and addressed to the Vice-President of the Committee of Privy Council. The information and suggestions contained in this paper no doubt will be of value in considering the status of industrial instruction in this country.

"In submitting this report so soon after our appointment, we have merely offered an opinion on some of the industrial requirements of this country, and have indicated the course of action which the Commission proposes to itself to follow. In doing so our object is to place at the disposal of the working classes some of the special educational aids, which by the liberality of the State, are given to other classes in this country, and, by the munificence of individuals and Government assistance, are afforded to the working classes in Europe. And without any expectation that we can effect all that is desirable, we hope to make a beginning of a work which enlightened statesmen, and practical men unite in thinking essential to the manufacturing progress of England, and which is yet more essential for manufacturing progress among us.

SAMUEL H. BINDON, Chairman.	FREDERICK MCCOY.
	J. F. RICHARDSON.
J. J. BLEASDALE, D.D.	GEORGE ROLFE.
DAVID BLAIR.	D. THOMAS.
J. G. BURTT.	W. M. K. VALE."

Twenty-eight years have passed since that Report was issued, and few of those who signed it remain, but their work remains and has developed, and their names deserve to be held in honoured memory as the prescient pioneers of technical instruction in Victoria.

A second report was furnished 11th November, 1869:—"Feeling that the lectures, in order to command success, should be of the highest order, and judging from the dictum of Professor Tyndall that lectures of such a character can be rendered acceptable to mixed audiences, as the lectures of Professor Huxley to the working classes of Nottingham have been, we put ourselves in communication with gentlemen of high scientific attainments, with the view of preparing a course of such lectures for delivery in Melbourne in the first instance." The establishment of a School of Design is announced, numbering 160 pupils, and of a School of Technical Instruction, founded by members of the Carpenters and Joiners' Society. Invited to visit and confer with that body, the Commissioners found that, although the school had been opened only four nights, there were twenty pupils, and that classes for making of models, and for mechanical and other drawing were in progress. In conclusion, the Commissioners say, "We may now close our report by stating that we believe that special and fitting instruction of a scientific character is of as much importance to the community at large as is special instruction for the professions. . . . The artisan in this country should at least receive as much care from the Government as he does in England; he has not the advantages of instruction here as in England, where schools of design, lectures, and museums of industry and art are daily on the increase. It is in contemplation to have a conference in the early part of the year with representatives of the several trades, and manufacturers, who can meet with us, and others, and confer upon many of the topics to which we have now alluded. This course has been adopted in London on several occasions with advantage, more especially at a conference of working men recently presided over by the Earl of Lichfield. We hope for similar results here." It will be noticed how careful the Commissioners watched what was being done in the mother country in the direction of technical instruction, and how readily they followed the example thus set, also that more than a quarter of a century ago at the Antipodes, was forestalled the action of King's College, London, in holding art classes in connection with the Carpenters' Company.

A third report, dated 7th May, 1870, mentioned the establishment of six schools of design, aggregating 600 pupils, and states that the Commission had printed 5,000 copies of reports and tracts on technology for gratuitous circulation, and expressing satisfaction at the progress which technology has made in public opinion since the appointment of the Commission, remarks that a rare unanimity in the Victorian press has materially helped to create and foster this feeling, acknowledging how much is due to the press for its able and constant advocacy; but that it does not appear that this branch of education has been placed on the footing it deserves in the State schools. Whatever success had, so far, been achieved by the Commission was with very limited means, its expenditure from 6th January, 1869, to 6th May, 1879, being only £200.

The action of the Commission produced an effect upon the Education Department. The Minister of Public Instruction, in Report for 1871, states that attention has been called, and continues to be directed, to the growing importance of technological instruction as affecting the industrial progress of the country, adding—"We permit instruction in mensuration, geometry, and algebra to be given within the hours of secular instruction." However, drawing was the only subject specified in the "Programme of Instruction," under the head of "Technological Instruction," and seven years elapsed before the Department enlarged this "programme." The Minister's Report for 1878-9 states that a circular has been issued to the teachers that all should qualify themselves to give instruction in at least one branch to be selected at the option of each teacher from the following list, viz. :—

Physiology, with special reference to the laws of health.
Botany, with special reference to the most useful products of Victoria.
Geology and Mineralogy.
Electricity and Magnetism, with applications to telegraphy, signalling, &c.
Acoustics, Light and Heat.
Mechanics and Hydrostatics.
Chemistry, with certain applications of it to the arts.

To this list it is intended to add metallurgy, as taught in the Schools of Mines at Ballarat and Sandhurst, and agricultural chemistry.

The Schools of Mines at Ballarat and Sandhurst were not then, though they are now, branches of the State Education Department, they were established at each of those great gold fields centres by private local effort, to which the Government wisely contributed pecuniary assistance. That they filled an important place in supplying the kind of technical instruction needed for scientific gold-mining, will be seen from the report of the Secretary for Mines, R. Brough Smythe, F.G.S., dated July 14th, 1873 :—Ballarat School of Mines.—Subjects in which instruction is given :—Mathematics, mining and land surveying, metallurgy and assaying, chemistry. The lecturers in the school and others, their assistants, examine at stated periods, captains of shifts, underground managers, engine-drivers, engineers and surveyors, who present themselves as candidates, and certificates are given to those who prove themselves competent. The expenditure from the formation of the school in 1870 to June 30th, 1873, was £2,340, of which £1,500 was contributed by the Government.

The School of Mines at Sandhurst (now named Bendigo) was conducted on the same enlightened lines, although on somewhat smaller scale, its expenditure during the same period being £1,105, of which £500 was Government grant. A noticeable feature in the instruction by the Sandhurst school was that the pupils were taken out periodically to various mines for practical instruction. Both schools were provided with laboratories, mineral collections, books and maps.

Both these schools of mines have, as might have been expected, progressed greatly since their first inspection in 1873, and naturally the subjects taught have been widely enlarged, comprising, besides those mentioned in the report quoted, geology, mineralogy, petrography, botany, mechanics, telegraphy, machine and building construction, machanical, geometrical, and architectural drawing. There are workshops for practical instruction in the mechanical arts and trades, *e.g.*, wood-carving, carpentry, engineering, smith and iron work, brass casting, and metal work generally, and at Bendigo the plant, which is very extensive, includes a steam-engine to drive lathes, &c., and a good forge with bellows ; there are two instructors respectively for carpentry and metal work. The mining laboratories of both schools are fully equipped with machinery and appliances requisite for the reduction of quartz and practical treatment of auriferous mine products, and the Ballarat school boasts the possession of a complete plant for the treatment of gold ores by the "Newbery-Vautin" chlorination process, also, it is alleged, the most complete apparatus in the southern hemisphere for testing vacuum and steam pressure-gauges. Attached to each of these schools is a meteriological observatory, where the usual daily observations of rainfall, temperatnre, atmospheric pressure, direction and force of the wind, &c., are regularly recorded and despatched to the Government astronomer at Melbourne; and daily weather reports and forecasts are sent to the local newspapers. Both schools possess extensive and admirable musuems, comprising natural history collections and thousands of specimens illustrative of the geology, mineralogy, and the living and fossil flora and fauna of the globe, besides a large number of specimens of rocks, minerals, ores, and fac-similes of gems, as well as fossils, typical of the different geological strata ; and in the Bendigo Museum there are valuable examples of the arts of the Aborigines of Australia. Both museums are rich in geological maps and sections, and sketches of scenery exhibiting some of the striking features of the rock formations in Australia. The number of lecturers at the Ballarat School of Mines is eleven, two of whom are professors ; the students attending practical classes number about 400. The teaching staff at Bendigo is fourteen, and no less than 935 individuals received instruction either in day or evening classes in one year (1890). Ballarat is reckoned the more advanced, being affiliated to the Melbourne University since April, 1887, the privileges conferred by affiliation, however, being restricted to matriculated students. The census of 1891 gives the population of Ballarat (comprising the coterminous municipalities of the city of Ballarat and the town of Ballarat East) as 40,849, and Bendigo, 26,774; the former is 75 and the latter 101 miles from Melbourne.

There are Schools of Mines at eight other gold fields centres, established with similar aims, conducted on like principles, though of course, on a much smaller scale. These schools are enumerated in a Schedule appended, showing the amount contributed to each by the Government during the last five financial years, also the population of each place, and its distance from Melbourne. Similar information is likewise given regarding Schools of Art and Design—fourteen—subsidised by the State, and now under the control of the Education Department, the State grants being restricted to certain specified subjects bearing a distinct relation to the industrial arts, and the success with which they are taught. That the work done in these schools is good work, is evidenced by the fact that it is appreciated all over Australia, for young men who have passed the mining course at either Ballarat or Bendigo are eagerly sought for to take charge of mining properties in different colonies, particularly in Western Australia and Queensland. They have even been sent for from such distant places as Borneo and the Straits Settlements.

The Working Men's College in Melbourne is the principal institution in the colony for imparting general technical instruction. Founded in 1883 mainly by the liberality of the late Honorable Francis Ormond, Member of the Legislative Council, who also endowed a college which bears his name in connection with the Melbourne University,* the Working Men's College is situate in the centre of the city of Melbourne, on land given by the Government, near the magnificent public library. It was opened to students in 1887 and consists of two buildings, one devoted to class and lecture-rooms and offices, the other to workshops and art class-rooms. It is governed by a council, on which are represented the founder, the Government, the university, the public library, and the subscribers. As its name implies, the college is intended to improve the general and technical education of the working classes, but it is open to all, women as well as men. The class work is carried on almost entirely in the evening, between the hours of 7 and 10.15 p.m., but on Saturday mornings lectures in science are given for the special benefit of State school teachers, and facilities are offered to country students to attend by the issue of cheap railway tickets—the Victorian railways being the property of the State.

The list of subjects taught is very comprehensive and varied, including:—

Applied Electricity.
Applied Mechanics (Construction).
Do. (Design).
Do. (Machines).
Arithmetic and Mensuration.
Botany.
Building Construction.
Carpentry.
Coachmaking & Drafting.
Cookery.
Dress-cutting and making.
Drawing (freehand, mechanical and architectural).
Elementary Mechanics.
Geology.
Geometry (practical, plane and solid).
Graining.
Marbling.
Modelling.
Photography.
Physics.
Physiology.
Plastering and Plaster-casting.
Plumbing.
Sign-writing.
Steam and the Steam-engine.
Surveying and Levelling.
Tailors' cutting and fitting.
Telegraphy.
Trigonometry.
Turning and Fitting.

Courses of study extending over three years are laid down for students in the various technical classes, and the four following certificates are issued:—

1st Class—Ordinary certificates to those students who pass the annual examination in any class.

2nd Class—Credit certificates to those students who pass the examinations with credit.

3rd Class—Technical certificates to those students who pass all the examinations in the two years' course.

4th Class—Expert certificates to those students who have passed all the examinations in the three years' course.

Before gaining expert and technical certificates the student must produce evidence of having been engaged in practical work for some time. The largest number of students enrolled for any one term has been 2,393. The number during the last year of which I have been able to obtain statistics, namely, 1894, is as follows:—

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* The amount contributed by Mr. Ormond to the Working Men's College was £15,000, and to Ormond College, £60,000.

Indentured apprentices	105
Apprentices not indentured	404
Adults over 21 years of age	233
Females	428
Total	1,170*

Number of instructors, 42.

The fees paid by students range from 5s. to 20s. per term, the average being 7s. 3d.

Up to the 30th June, 1894, the expenditure was:—

	£
On buildings	50,373
Salaries and wages	29,332
Sundries	18,173
Total	97,878

And the receipts:—

	£
From Government	50,112
Donations and subscriptions	23,591
Students' fees	15,727
Other receipts	8,511
Total	97,941

The Gordon Technical College at Geelong, resembles on a reduced scale, the Working Men's College, Melbourne; it has also been established about the same length of time—ten years. Vested in trustees, the institution is managed by a president, nominated by the Government, and a council of eighteen members elected by the subscribers. The subjects taught are similar to those of the larger institution. The staff consists of a director, secretary, and eighteen instructors, the number of pupils averaging 250, chiefly of the artisan class.

Another Working Men's College is established in the borough of Horsham, about 200 miles from Melbourne. Its aims are similar to those of its metropolitan prototype, its extent and scope being about on a par with that at Geelong.

There is a School of Horticulture at Richmond, near Melbourne, number of students limited to 25, but the lectures are free to all interested in horticultural pursuits, ladies included. Instruction to the students is free, and the course includes practical horticulture in all its branches, and botany. Examinations are held yearly, and certificates of proficiency granted, the examiners being appointed by a government board designated "The Board of Horticultural Advice."

As successors to the experimental farm, mentioned in the beginning of this paper, the site of which is now a populous suburb of Melbourne, Victoria possesses two agricultural colleges—one at Dookie, 130 miles from Melbourne; the other at Longerenong, distant 190 miles. Each has accommodation for 40 students, the amount charged per head being only £26 5s., no charge being made for instruction.

The Dookie College is the principal one, and has an area of some 4,500 acres. This is sub-divided so that agriculture, horticulture, and stock raising in all their various branches may be thoroughly taught to the students, who have to perform nearly the whole of the actual labor on the place, so as to obtain practical as well as theoretical knowledge. In the agricultural portion, wheat, oats, barley, &c., and root crops are grown. The students obtain a knowledge of tillage implements and the machinery used in the various processes. Agricultural chemistry is also taught and geology in order to know all about the natural composition of soils, their deficiency, &c., and where science may supplement these. A large orchard has been planted in which every description of fruit which can be produced in the colony is grown. Fruit raising in all its branches is taught, also grafting, pruning, and every detail connected with horticulture. Fruit drying, canning, and preserving, also the packing of green fruit for market. There is a large vineyard in full bearing, and in connection with this every branch of viticulture is taught, wine-making receiving especial attention, the drying and preparation of raisins, currants, also. There are a large number of olive trees grown, and oil making from them learnt, also the manufacture of oil from linseed and sunflower. There is a good dairy farm on the place with excellent cattle. Here milking, butter and cheese making in every detail is taught. Cattle, sheep and pigs are kept, and stock-raising in all its branches learnt by the students. Bees are kept, and bee-keeping taught. Mulberries grow well at Dookie, and sericulture is taught also. All descriptions of poultry are kept, and all knowledge in that line imparted. The production of flax and other fibres also receives attention.

Longerenong is on a smaller scale, but the basis of instruction and working is on the same lines as Dookie.

[The above particulars of these agricultural colleges have been kindly furnished by Mr. J. M. Sinclair, Superintendent in London of Victorian Exports.]

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* Since this has been in type, I have learnt that the number in 1895 reached 1,338, viz., 896 males, and 442 females.

The following figures represent the financial aspect of these institutions for the half-year ended 30th June, 1895:—

	Dookie.	Longerenong.
Receipts:—	£	£
Students' fees	539	524
Sale of farm produce ..	342	186
Total..	£881	£710
Expenditure:—		
Agricultural college ..	716	816
Experimental farm	652	749
Total..	£1,368	£1,565
Cost to the State	£487	£855

Perhaps some day these farms may be self-supporting, but their value to the State consists in the education of students to become trained, scientific, and practical agriculturists, whose knowledge translated into action should enrich themselves and the community to which they belong, added to the value of the experiments conducted on the farms, the results of which are fully and widely made known.

In 1890, when the finances of the colony were very prosperous, the Legislature appropriated £43,000, of which £30,285 has been expended up to 30th June, 1896, "For establishing a system of technical education by the employment of experts to supply instruction in connection with the introduction of new vegetable products and the improvement of existing agricultural methods;" and £11,000, of which £6,577 has been expended up to the 30th June, 1896, "For publishing agricultural reports, including illustrations in connection with the educational work of the experts and the distribution of the bonuses* generally." The reports, as may be supposed, are valuable and instructive upon the subjects treated, and they are widely distributed, free, by the Department of Agriculture. A direct consequence of this liberal legislation, and the information thus disseminated has been an immense increase in the exportation of food products from Victoria to England.

In 1870, the Technological Commission complained that the technological branch of education was not placed on the footing it deserves in State schools.† This reproach has long been removed. Facilities are now offered, and have been for many years, for learning extra subjects connected with technology, amongst them being mensuration, algebra, euclid, geometry, physics, physiology, drawing, painting, modelling, the number of pupils in such extra subjects being last year 3,760—the total number of scholars receiving education in State schools, 1st January, 1896, was 232,052—112,399 being girls. The number of State schools was 1,922, besides 867 private schools and colleges having 17,863 male and 20,199 female scholars—at all of which a high standard of education is attainable.

Bearing, though indirectly, on technical education, it should be mentioned that every town in Victoria possesses a Free Public Library and Reading-room, the number being 436, containing more than 610,000 volumes, besides newspapers and periodicals. The cost of the buildings has been £405,464, and they are visited by upwards of 3,200,000 persons annually.

Attached to the Patent Office, Melbourne, is a Free Library of 6,100 volumes, consisting of the patent records of Great Britain and all the Colonies, the United States, France, Italy, Germany, &c., and other works relating to patents and trade-marks, also 400 models of patented inventions.

The Melbourne Public Library is one of the finest free libraries in the world; the building has cost upwards of £185,000; it contains more than 390,000 volumes, and is annually visited by more than 400,000 persons.

In the same building is a National Gallery, containing upwards of 400 oil paintings, many being the works of English and continental artists of high repute; 2,600 objects of statuary, &c., and 13,200 drawings, engravings, and photographs. There is a school of painting in connection with this institution, attended by eight male and 26 female students, and also a school of design, having 38 male and 85 female students. The students are encouraged to paint original works, by which means it is hoped the foundation may be laid of a school of art, of which the subjects are purely Australian.

But bearing more directly upon the subject of this paper is the Industrial and Technological Museum, which is also in the same building as the Public Library and National Gallery. This museum contains upwards of 52,000 specimens of mineral and vegetable products, manufactures, machinery, &c., realising the hope expressed by the Technological Commission in its first report in 1869.

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* £171,000 was at the same time appropriated for bonuses on the exportation of dairy produce and to growers of grapes and other fruits, also for canning and drying, and for the manufacture of flax, hemp, silk, &c.

† Education in Victoria is free, secular, and compulsory.

VICTORIA.

Table showing Expenditure from Government Grant for Technical Schools; also the Population at each place according to the Census of 1891, and the distance from Melbourne.

	Place.	1891-2.	1892-3.	1893-4.	1894-5.	1895-6.	Population.	Miles from Melbourne.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		
Schools of Mines.	Bairnsdale	1,650 0 0	545 15 0	300 12 1	447 18 4	627 14 2	3,270	170
	Ballarat	3,000 0 0	1,896 15 0	1,440 19 4	1,321 8 10	2,448 7 10	40,849	75
	Bendigo	3,000 0 0	2,235 11 4	935 12 10	1,388 7 4	1,567 8 8	26,774	101
	Castlemaine	600 0 0	450 0 0	511 2 3	585 3 0	596 13 9	4,770	78
	Clunes	400 0 0	228 6 10	8 5 10	..	..	3,486	97
	Creswick	400 0 0	219 10 0	..	..	..	3,095	85
	Daylesford	1,000 0 0	362 7 6	78 17 6	188 9 9	385 4 3	3,839	76
	Harrietville	100 0 0	50 0 0	..	..	..	..	..
	Maryborough	2,606 1 8	370 5 0	211 0 0	264 12 8	305 1 10	4,994	112
	St. Arnaud	300 0 0	208 17 6	160 10 0	194 4 11	214 17 11	3,045	159
	Stawell	1,100 0 0	486 0 0	601 11 2	908 8 6	992 10 10	5,183	150
		14,156 1 8	7,053 8 2	4,248 11 0	5,298 13 4	7,137 19 3		
Schools of Art.	Technical Art School, Ballarat	1,000 0 0	671 15 0	997 12 9	1,047 6 6	1,050 7 7	24,257	74¼
	Ballarat East	801 18 1	900 3 3	138 0 0	321 12 6	448 14 4	16,592	75
	Balwyn			73 12 6	128 8 9	123 7 0	1,283	8
	Collingwood			129 17 6	121 2 6	99 12 3	35,070	2
	Echuca			47 12 6	80 1 3	128 5 0	4,354	157
	Fitzroy			89 12 6	72 13 0	58 8 4	32,453	2
	Footscray			32 12 6	95 17 6	64 15 9	19,149	4
	Nhill			168 10 4	57 6 0	132 14 7	1,102	248
	Port Melbourne			85 6 3	65 15 0	38 15 7	13,067	2½
	South Melbourne			106 17 6	77 19 2	68 15 9	41,724	2
	Warrnambool			47 5 0	113 2 6	170 6 10	6,582	166
	Williamstown			18 0 0	53 5 0	29 13 4	15,960	9
	Kyneton	658 6 8	541 17 6	284 13 10	341 8 8	441 1 9	3,371	58
	Sale	600 0 0	543 8 0	699 15 2	517 1 3	798 0 11	3,442	128
		3,060 4 9	2,657 3 9	2,919 8 4	3,092 19 7	3,652 19 0		
	Gordon Technical College, Geelong	800 0 0	483 0 0	292 13 6	268 12 5	346 19 5	17,445	46
		2,500 0 0*	..	..	..	..	..	..
	Working Men's College, Melbourne	5,500 0 0	6,621 4 6	2,478 2 10	2,373 1 11	2,521 3 5	..	..
		3,000 0 0*	..	..	..	..	..	..
	,, ,, ,, Horsham	300 0 0	250 7 6	647 10 8	795 13 0	487 0 11	2,678	204
	Miscellaneous	..	..	257 0 2	149 18 0	627 2 2	..	..
	Totals	29,316 6 5	17,065 3 11	10,843 6 6	11,978 18 3	14,773 4 2	..	..

* Buildings.

I have now completed my account of the beginning, the development, and the present condition of technical instruction in Victoria. My paper contains nothing original, it is merely a compilation, somewhat diffuse, from Parliamentary papers and reports by the Government statist, but, at all events, it shows that Victoria has not been slow to follow the lead set by the mother country in recognising the vast importance of the subject and adopting similar means to attain the object in view, which comprises the utilities, the conveniences, and the graces of life, and by increasing production, the consequent amelioration of the conditions of existence—the ultimate outcome of technical education.

TECHNICAL EDUCATION IN QUEENSLAND.

By D. T. Lyons,
Emigration Agent and Lecturer for the United Kingdom.

For many reasons, technical education in Queensland, until recently, did not receive the consideration to which many at present deem it entitled. Now and again the importance of giving it some place in our education system has been urged on the authorities by those who recognise its value as a factor in the development of the vast resources of our country, and as a necessary means to enable our people to hold their own in the struggle of the nations for supremacy.

An outcome of these suggestions, was the introduction of lessons in agriculture into the programme of instruction for country schools, with practical lessons in horticulture for the school children of Brisbane and the suburbs. This was accompanied by the establishment of "Arbor Day," an institution intended to encourage in the pupils of all our schools a taste for, and practical knowledge of, the cultivation of ornamental trees, fruit trees, and trees of industrial value.

Arbor Day marks the opening of the season for planting, and is made the occasion of accentuating the motive of the institution. It is now very popular, and has induced many, who might otherwise have remained indifferent, to recognise the value of an extended application of technical education. At present technical education in Queensland is active. There are in Brisbane, a Technical College and a College of Pharmacy, with two technical museums, supported out of public revenue—one geological and the other agricultural, the latter attached to the Department of Agriculture.

At Laidley, 51 miles from Brisbane, an Agricultural College has recently been established.

The amount voted for application in various ways to purposes of technical education, for the years 1896-7, was £6,165, to which sum the public contribute an equal amount. From the Government allowance, sums are supplied for the support of Schools of Art, which may be considered as given in aid of technical education, though many of these institutions are merely reading-rooms, and not yet in a position to fully fulfil the original intention of their formation.

Technical classes, however, are conducted in conjunction with the Schools of Art in the following towns:—Brisbane Technical College, South Brisbane, Ipswich, Toowoomba, Gympie, Maryborough, Bundaberg, Rockhampton, Mackay, Charters, and Townsville.

The following subjects are dealt with in the Brisbane Technical College:—Machine construction and drawing, wood-carving, anatomy for artists, applied mechanics, electrical engineering, electricity—introductory to practical work, dressmaking, garment-making, dress-cutting, tailors'-cutting, elocution, chemistry, laboratory practice, botany, carpentry, joinery, cabinet-making, staircase-building, handrailing, elementary wood work, type-writing, sewing, garment-cutting, art needlework, and design, nursing, cookery, physics; lectures given under the auspices of the University Extension Council, freehand and model drawing, modelling in clay, and painting.

The painting classes have developed into an art school open all the week. Of the other subjects, some are taken in the evening, and some during the day. The number of pupils connected with the College alone for last year was 843, being 100 more than for the previous year, whilst extended accommodation has already been provided for a considerable increase anticipated this year. The enrolment at the opening this year was nearly twice what it was at the opening last year, That there is a growing desire on the part of our young people to devote their spare time to the attainment of knowledge calculated to improve their surroundings, and constitute them more valuable members of the community, is matter for congratulation. It is evident that those who derive recognised benefits from their acquired knowledge, will naturally become potent factors in the formation of a public opinion, that must work towards affording wider opportunities for technical instruction. As agriculture must, in the near future, occupy a considerable portion of the population, the establishment of an Agricultural College is perhaps the most important concession of the Government to the cause of technical education.

The prospectus of this institution has just been issued. The course of study involves three years' work.

First Year. — Agriculture, horticulture, dairying, carpentry (industrial), agriculture, horticulture (lectures), arithmetic, book-keeping, chemistry, drawing, English composition.

Second Year. — Agriculture, horticulture, dairying, blacksmithing (industrial), agriculture, horticulture, dairying (lectures), anatomy and physiology, botany, chemistry, entomology, geology, physics, surveying.

Third Year. — Industrial (special work), agriculture (lectures), agricultural chemistry, bacteriology, botany, landscape gardening, meteorology, mechanics, veterinary science, zoology.

All students will be required to do manual work at least one-half the working time. This labour will be applied upon the farm, gardens, orchards, dairy or workshops.

The teaching staff will include :—

Principal and Instructor in Agriculture.
Instructor in Chemistry and Natural Science.
Instructor in Surveying and English.
Instructor in Horticulture.
Instructor in Dairying.
Teacher of Book-keeping.
Farm Foreman and a Mechanic.

Besides this, the Department of Agriculture, through the medium of travelling dairies, and by the lectures of experts on a variety of subjects connected with the soil, has undertaken to furnish special technical instruction throughout the country to those anxious to avail themselves of the privileges thus afforded them.

THE GROWTH OF TECHNICAL EDUCATION IN TASMANIA.

By J. R. Tranthim-Fryer.
Principal of the Art Section of the Government Technical School, Hobart.

The need of technical education had been keenly felt by all classes of art workers and others in Tasmania for some time, before any successful efforts to establish technical schools were made. In proof of this, I remember an eminent Hobart architect telling me—when I was visiting Tasmania—that on one occasion he required a piece of ornament different from the ordinary size and style, and there being nothing in any of the imported stock that would suit, it had to be made. Now, there was no one who could undertake the modelling of it, so it had to be carved in wood, from drawings, then moulded, and cast in plaster. Thus the difficulty was overcome, but in an expensive and not very satisfactory manner.

This question might possibly arise—If the industrial arts in Hobart were so behind that a simple architectural form, such as the one mentioned above, could not be modelled there, how was it that carvers skilful enough to undertake the work were obtainable? The answer is this. Hobart was for many years a ship-building centre, consequently there was lucrative employment on figure-heads, fittings, &c., and at the time of which I am writing, some of the old carvers were still resident there.

Many attempts were made at different times and in various ways, to start something that would supply the want of a technical school, and new comers to the beautiful island remarked the absence of any institution for such training. Gradually a feeling was awakened that a technical school, or, at any rate, classes were necessary. Several attempts were made to enable students and apprentices to work at machine and freehand drawing, &c., but very soon these developed into art classes for amateurs, which only lasted a short time. Other efforts equally sincere, were made, but collapsed after a few months. Then the energy of those interested in education was directed into another channel, juvenile exhibitions were started, and every kind of work done by the youth of both sexes was brought together, criticised, and awards were given to encourage them to develop, as far as the slender advantages allowed, their particular gifts for art or handicrafts. By these means the interest of the Tasmanians was gradually awakened, and a general desire grew for a technical school, where arts and crafts could be properly and thoroughly taught. However, nothing was done till about ten or twelve years ago, when the Hon. G. P. Fitz-Gerald, M.H.A., then member for West Hobart, and Alex. Morton, Esq., F.L.S., &c., gave the matter their serious consideration, and with success. A committee was formed and gazetted, the Government provided temporary rooms, voted a sum of money, and the technical education system was established in Tasmania. Classes were held regularly for the study of elementary science, technical art, building and machine construction, applied mechanics, chemistry, and domestic economy. These were well attended and good work resulted. As the requirements of this young technical school grew, the rooms were found to be far too small, and the Government then had plans prepared for a new one. These being approved, Sir Robert George Crookshank Hamilton, K.C.M.G., &c., then Governor of Tasmania, laid the foundation-stone of the new school, which was opened about five years ago. A short description of the building may not be out of place here. It is a fine and imposing one of brick and stone, two storeys high. In the left wing on the ground floor is a committee-room and secretary's office, class-rooms for drawing, modelling, casting, carpentry and joinery, turning, &c. The other wing on this floor is occupied by the Government Analyst and his staff, and consists of offices, laboratories, and furnace-rooms. On the next floor are class-rooms for the study of machine and building construction, metal working, applied mechanics, veterinary science, experimental chemistry, metallurgy, mineralogy and assaying, laboratories, furnace-rooms for smelting, and a splendid lecture theatre fitted with all the most modern appliances for demonstrations. During the winter season illustrated lectures are given every week on the various subjects taught in the school, and scientific matters of interest and educational value to students. These lectures are so popular that the large theatre is often crowded in every part, temporary seats being provided on the platform and in the passages. When this school was opened many people considered it far too large for the requirements of Hobart for the next twenty-five years at least. This has already been proved to be erroneous, as it is now too small for the work being done there, and in many cases, two classes are obliged to share the same room, using it on alternate nights, and any further extension of the work is practically impossible in the present building.

Simultaneously with the growth of the school in Hobart one had been formed in Launceston, the northern city of the island, where there is a fine system of technical education with many students, amongst whom a splendid work is being done.

Schools were also established in some of the country towns, and were very much appreciated, as in some cases students travelled great distances in all weathers to attend them.

This outline of the founding and growth of technical education in Tasmania, does not by any means exhaust all that can be said on the subject. There were many obstacles to overcome. The "technical education party" in the House, the committee, and the instructors, have all had to bear their share of the fight, and the success of their efforts should stimulate all concerned to continue the good work. So far all went well, and it seemed as if the rising generation in Tasmania would have every advantage of studying the *technique* of their particular arts and handicrafts. But the wave of financial depression, which wrought such sad havoc over our island continent, reached Tasmania. The work for technical education, so well begun, and which had already shown such good results, was paralysed to a great extent owing to the Government vote being reduced by at least one half, and progress or development was next to impossible. The country schools were, in many cases, compelled to close, and those in Hobart and Launceston were so crippled by want of funds that at least half their good work was stopped. Salaries were reduced to such an extent that no instructor (even the best paid) could devote more than one-third of his time to the work of the school and many not even that.

The island is full of native ability which only requires thorough training and proper development to spread the name and fame of Tasmania all over the civilised world. The extraordinary beauty of the scenery, and its exquisite colouring, must have a good influence upon the minds of the young Tasmanians, and a love of the beautiful is, to a great extent, part of their birthright.

There is already a large percentage of earnest students, who love to paint the beautiful scenery, and some of them with a great deal of artistic success. This may be taken as a proof of what might be accomplished under more favourable conditions. Why should not technical art schools be made to occupy as important a place in the development of Tasmanian ability as the splendid schools of the "City and Guilds of London" do here?

It is earnestly hoped, that with the return of prosperity to the colony, the Government will vote a sum for technical education, that will enable the committees to extend the valuable work of their schools. We may then hope to see some of the splendid natural resources of the island developed fully, and utilised in all directions.

The beautiful natural fauna and flora of the colony taken as a motif, and rendered in the fine wood or stone, with which Tasmania abounds, might with distinct artistic advantage be applied to our public and domestic architecture. There is no reason why our decorations should not be as essentially Tasmanian as our beautiful mountain flowers and berries. Before this desirable state can be brought about, it is above all things necessary that students should be taught to know our fauna and flora. I venture to assert that no thinking man or woman will deny that our waratah, native laurel, wattle, eucalyptus, and most of our numerous ferns could be used for applied decoration with as much artistic success, and infinitely more suitability than the acanthus, lotus, honeysuckle, or papyrus of the ancients. If this were done, all would learn to see and appreciate the beauty a bountiful nature has so lavishly bestowed upon us. Tasmanian architecture would then be worthy of its country, decorative art a living thing, and we should be freed from the bondage of continually re-doing what others have done so much better, because they *went to nature* for inspiration, whereas we, who use their decorations, can only pose as copyists (more or less bad) of forms which are not sacred to us, and have no meaning for our time. It has been wisely said that "He who follows is always behind," and it is neither desirable nor necessary that Tasmanians should be classed amongst the followers, to be content always to use the brains of others, who could never have had a more beautiful material to work upon.

If the Government will study the best interests of the people it represents, we shall have well equipped technical and art schools, where students can learn what to cultivate and what to avoid. Then, with the practical application of native and familiar natural forms to constructive and decorative arts, we might lay the foundation of a school of architecture and decoration worthy of our colony.

The federation of Australasian technical schools for examinations would be a distinct advantage. So far there is an idea prevalent in Tasmania, and, indeed in many other colonies, that South Kensington is the centre to which work should be sent, and from which all certificates must be issued. This is a decided mistake on the part of the governing bodies of Australasian technical schools, and it has obtained such a hold that it will take a great deal of uprooting.

That it is possible for educational institutions to attain a high standard, and yet remain Australian has been proved by our universities, those of Sydney and Melbourne in particular. They conduct their own educational course, and so high is their standard, that it is no unusual thing for Australian students, who have failed to get through the examinations necessary for their degrees, to come to one of the old world universities to pass the examination, which they do (without further study) often with honour, usually taking high places. There is no reason why the standard of technical education should be lower than that of our universities, and surely no one is so well fitted to examine the subjects taught in the technical schools (which are necessarily influenced by local surroundings and conditions) as those living in the country and familiar with the requirements of Australian life. All who desire to see students possessing certificates from South Kensington seem to have the idea that a certain number of them will make the recipient as successful as some particularly eminent men who, in London, have gained similar ones. This very prevalent idea is ridiculous on the face of it. The regular attendance at the schools, the association with so many clever fellow students, the daily intercourse with, and advice of the many great masters of arts and crafts at South Kensington, the advantages of libraries, museums, and the many other opportunities of students attending these schools are, I feel sure, much more to do with the forming, training, and making a great or successful man than the intellectual effort required to pass examinations. But it would seem as if many of those directing technical education in Australasia think otherwise. I would like it to be clearly understood that these statements are made solely in the interests of students in our colonies in general and Tasmania in particular. My ideas on this subject are strengthened by the opinions of several eminent artists and others, with whom I have had the pleasure and privilege of discussing the matter. If the committees directing technical education in Tasmania and elsewhere, feel that certificates issued by local schools are of little value, let them bring about the union of all technical colleges and schools throughout Australasia, with, say, Sydney, N.S.W., as head quarters. Then a universal standard could be arrived at, for all subjects taught in common throughout the colonies. In the case of those which bear solely upon the natural products or manufactures of individual colonies, they must be presided over by local committees, and special certificates granted for them.

This short account of the growth of technical education in Tasmania, will at least, inform those who are interested in that colony (appropriately called "The gem of the southern seas") that there are men doing the best they can, willingly and without payment of any sort, for the benefit of young colonials. I allude to the members of the various committees governing the schools, and more particularly to those gentlemen in Hobart, with whom I have been intimately associated during my connection with the department of technical education in Tasmania.

In conclusion, I would again like to express the hope that the Government and members of Parliament will soon see their way clear to vote such a sum of money for technical education, that the committee will be enabled to carry on their fine work properly, and extend the range of subjects taught in their schools. That being done, there is no need to fear the result. The natural ability of the Tasmanians will ensure success in their studies, given a fair chance to develop their gifts.

The fame of Australasians for excellence in athletic sports on land and water is very generally known and accepted all over the British empire. The qualities of intellectual brightness, pluck, energy, and determination have every opportunity to develop in sport and athletics, hence their achievements in that direction. Those who know colonials well, will not doubt for a moment their success in the cultivation of artistic and mechanical gifts. The opportunity given, we can look forward confidently to the time when Tasmanians will be known far and wide for their fame in science, arts, and handicrafts.

PROGRESS OF TECHNICAL EDUCATION IN NEW BRUNSWICK.

By Philip Cox, Ph.D.,
Principal of the Grammar School, Chatham, N.B.

A short time since, the Hon. L. J. Tweedie, Provincial Secretary, handed me a circular from Mr. C. A. Duff Miller, the Agent-General for New Brunswick, *re* the International Congress on Technical Education, and the advisability of making a brief report of the progress of such education in New Brunswick to the meeting of the Congress in London on June 15th inst. To me it is a matter for regret that the notice was so brief and my leisure so little that only a short *resumé* can be given.

Though its importance is generally recognised, technical education, as a branch of popular instruction, has been tried only recently and within narrow limits. This apparent neglect is easily explained. In the first place, a large and aggregated population seems necessary for the establishment and growth of such schools; and, in the second place, they are largely the outcome of public interest, being centred in one industry; of manufacturing zeal and competition; or as a means of reviving some decaying business demanding the fostering care of skilled and scientific labour. In New Brunswick, few of these conditions exist. The industries most attractive, as promising the largest and speediest returns, are lumbering and fishing. In these directions Nature is so prolific that the forests, rivers, and sea show no signs of exhaustion, and hence the rut of popular thought is being little turned from the old tracks. Moreover, to procure and prepare for market the products of these two great sources of provincial wealth needs little scientific or technical aid.

It is, too, no easy matter to institute departures from old customs and usages. The founders of our educational institutions thought only of providing academic instruction, an aim subsequently kept in view throughout all the changes the school system has undergone; for it was thought that technical education would be for the few at the expense of the many—a prejudice to be dispelled only by time and the growth of a more enlightened public opinion. Yet the movement has made some progress.

To the University of New Brunswick belongs the honour of applying the opening wedge; for, owing to the rapid development of the canal and railway systems of the Dominion after confederation, surveyors and skilled engineers were in great demand, a want which was partly met by the establishment of a department of Civil Engineering. This affiliated branch, well equipped with all apparatus for carrying on practical field-work, is growing in popularity, and sending out every year a number of well-trained engineers.

The wonderful development of electricity as a motor and illuminating power has been the means of adding another technical branch, that of "The Applied Sciences," to the University. At a large cost, a complete outfit of plant was imported and set up, and a competent electrician engaged. In close touch with the department of chemistry, this institution is meeting a new and increasing demand for skilled labour, and its graduates find ready and profitable employment as electricians in the Dominion.

In the introduction of technical schools, the city, as before suggested, naturally takes the initiative, for there are found the grouping of population, keenness of competition, and demand for skilled labour. St. John, the great winter port of Canada, can boast of two fine commercial colleges, thoroughly equipped with banks, custom houses, notaries' offices, &c., with every appendage and practical detail of the business that will stamp the education with reality. The graduates are in demand; for the passage from the college to the counting rooms of commercial houses is both easy and natural. A third institution of the kind has lately been established at Fredericton, the capital, and is meeting with success.

This is all that has been so far realised; but what does the future promise? There are signs of the tendency of education towards the practical in life finding a larger and fuller recognition in the common schools system of the province. The curricula of studies, as amended and enlarged from time to time, bear witness to this fact, despite the fears of some that it tends towards materialism in belief. Such, however, confound the means and end. If the simpler elements of craft and labour can be made the means of assisting to develop the child's faculties, and train the mind, hand and eye, to make them stronger and more perfect as organs, instruments, if you will, for directing and performing work, there must result a saving of time and preparatory labour in the passage from the school to the varied workshops of human industry. And why reasoning about and manipulating these rather than abstract quantities in algebra, geometry, and arithmetic, should be more likely to promote belief in materialism is difficult to understand. But, let the result be what it may, the utilitarian theory is forcing itself more and more upon people's attention and must result in radical changes in educational methods. St. John is attempting to grapple with the problem, and a meeting of the Board of Trade was held a few days ago to consider the feasibility of grafting some technical branches upon the public schools of the city. It was largely attended, and many able and carefully-prepared papers on the subject were read and discussed, these papers dealing especially with the relation between technical education and industrial progress, emphasising the improvements likely to be effected in the condition of the operative and mechanic and the general life and trade of the city. Something will evidently result from this meeting.

Since the opening of the great Canadian wheat-growing and grazing areas of the West, the farmers of the maritime provinces have suffered from competition; and it is beginning to be felt that to be able to hold their own and turn their proximity to the sea-board and English markets to the best advantage, more careful and scientific husbandry is demanded. Hence the agitation in New Brunswick for an agricultural college, affiliated if possible with the university, and where the students may take advantage of certain courses of lectures likely to be helpful to them in their technical studies.

Miscellaneous.

THE RESOURCES OF ABYSSINIA.

Ethiopia is a mountainous and very fertile country, the latter characteristic being especially true of the plateaus of moderate altitude (2,000 to 3,000 feet). According to the *Bulletin de la Société de Géographie Commerciale*, the products are barley, wheat, millet, maize, sorghum, flax, various oils, medicinal plants, potatoes, coffee, tobacco, sugar-cane, &c. There are vast forests; the sycamore, the mimosa, the tamarind, a variety of wild olive (reaching thirty feet in height), the lemon, the orange, and the coffee tree are among the principal species. The domestic animals are horses, donkeys, cattle, sheep, and goats. Birds and bees abound. The latter contribute largely in certain districts to the wealth of the country, their honey being used in the preparation of hydromel, the favourite native drink, and the wax serving for candles. The mountains contain gold, copper, iron, and rock salt. Potter's clay is common, and in many places very pure. The principal articles of export are coffee, gold, ivory, skins, gums, wax, and medicinal plants. The imports consist of cottons, silks, cloths, carpets, firearms, cutlery, hardware, provisions, and tools The French colony at Obock has opened a route for commerce to Harrar and various provinces of the Empire. A postal service has been established between Djibouti, Harrar, Addis Ababa, &c., and there is telegraphic communication between the two latter places In the interior, the service is by horse; from Djibouti by boat. Addis Ababa, the capital, has a permanent population of some 50,000; the total number of inhabitants of the country is 15,000,000. Addis Ababa is an important centre of trade. Harrar is the residence of Ras Makonen; it has a population of 42,000. This is the point of transit of all the commerce from the southern provinces. The goods are brought to the city from the interior by mules, and carried thence to the ports by camels. The annual value of the trade of Harrar amounts to over £1,000,000, and is growing steadily.

SPANISH SALT INDUSTRY.

The Spanish Governments held the monopoly of salt until 1869, when its manufacture and sale were declared to be free. In the early part of 1896, the Government proposed to resume its former monopoly, but finally decided to increase in its estimates the consumers' tax on salt, from 25 centimos (about twopence) to 50 centimos per inhabitant, and to authorise the various local governments of towns and villages to exercise the exclusive right to sell, or grant the privilege of selling salt, in order that the full amount of the estimate might be secured for the Government. The former tax of 9 centimos per kilogramme of salt has therefore been increased to 18 centimos per kilogramme, except for salt to be used in industries and agriculture, which can be taxed only 12 centimos per 100 kilogrammes if black, and 25 centimos per kilogramme if white. The United States Consul-General at Barcelona says, in his last report, that Spain is rich in salt, having many mines, marshes, and springs. The mines of Cardona are particularly famous, owing to th fact that they penetrate an enormous rock of salt, without crevices or covering, and brilliant with many different colours. Neither heat, frost, or rains have visibly diminished its colossal proportions, nor do its immense and marvellous caverns afford an adequate conception of its depth. Next in importance are the salt mines of Minglanilla, Añaran, Poza, Valtierra, Pancorbo, Manuel, Villena, Vilalgordo, Monovar, Villarubia, Onda, Sarrion, El Pinoso, La Rosa, Sariego, Villaviciosa, and Infiesto. Then there are plants for obtaining salt from water by means of evaporation. These include Antequera, Cabizon (in Santanda), and San Pedro del Pinatar (in the province of Murcia). There are in all fifty-five salt-producing mines in Spain, distributed as follows:—Alicante 2, Almeria, 2, Barcelona 1, Burgos 6, Cuenca 3, Guadalajara 12, Huesca 3, Lerida 2, Santander 5, Soria 2, Teruel 4, and Saragossa 15. In addition there are 161 unproductive salt mines, making a total of 216 in all Spain, covering an area of 2,789 hectares (hectare = 2·47 acres). In Salumera there are 36 salt factories, which produced in 1894, 12,987 tons of salt, valued at £160,000.

JAPANESE TOBACCO.

Tobacco is cultivated, to a greater or less extent, in every province of Japan. This is for the reason that in times of feudalism each locality was obliged to depend upon itself for the supply of everything of necessity. Owing to the existence of this custom for centuries, division of labour with respect to th production of commodities is not yet fully developed and the different sections are to a large extent sti self-supporting. The total acreage, yield, and yiel per acre, were as follows during the year 1894– 87,451 acres; a yield of 77,595,206 lbs., and yield per acre of 887 lbs. The acreage has recently it is said, declined in such industrial district as Gumba, Nagano, &c., while in districts hithert noted for the excellence of their tobacco, th acreage shows considerable increase, thus provin that division of labour is increasing among th different provinces. The following are the principa tobacco-producing provinces according to the lates available returns, those for 1894:—Ibaraki, with yield of 7,490,123 lbs.; Kagoshima, 5,462,417 lbs. Fukushima, 5,388,174 lbs.; Tokushima, 4,948,423 lbs. Okayama, 4,370,480 lbs.; and Tochiki, 4,164,161 lbs Japanese tobacco is exported, both in the lea and in the form of cigarettes, the principal custome for the former being England, while Corea and China buy the latter in larger quantities than any othe country. Leaf tobacco produced in Japan is so excellently dried, that though the importations are quite heavy, it is said to be able to realise a tolerable profit when its volume is swollen by moistening it Even 40 to 50 per cent. can be mixed in, and the tobacco thus manufactured can be sold at a low price All things considered, the Japanese leaf being larger than the Manilla, and also thinner, it is best adapted for wrapping cigars. In respect of manufacture Nagasaki, Kanagawa, Oita, Tokushima and Ibaraki are the principal provinces.

Obituary.

George Palmer.—Mr. George Palmer, the head of the eminent firm of Huntley and Palmer, who died at Reading on the 19th inst., was a member of the Society of Arts of long standing, having been elected in 1861. Mr. Palmer was born at Long Sutton, Somerset, on January 18th, 1818, so that he was in his 80th year. He removed to Reading in 1841, when he entered into partnership with Mr. Thomas Huntley. In 1857 he was Mayor of the borough, and in 1878 he was elected to represent it in Parliament. He was a great benefactor to the town of Reading, and in 1875 he presented a public recreation-ground in the King's Meadows, and in 1891 he dedicated another public park (called Palmer's Park) to the use of the people. He also took great interest in the Free Library and Museum, which he generously assisted. In 1891 a statue of him was erected by public subscription.

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FRIDAY, SEPTEMBER 3, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

DETERIORATION OF PAPER.

The Council of the Society of Arts have appointed the following Committee to investigate the causes of the deterioration of paper: Major-Gen. Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., Chairman of the Council; Sir William Anderson, K.C.B., D.C.L., F.R.S., Michael Carteighe, C. F. Cross, F.C.S., Sir John Evans, K.C.B., D.C.L., F.R.S., Richard Garnett, C.B., LL.D., Hugo Müller, Ph.D., LL.D., F.R.S., W. J. Russell, Ph.D., F.R.S., William Luson Thomas, R.I., Professor J. M. Thomson, F.R.S., Henry R. Tedder, F.S.A., Dr. Quirin Wirtz, M.A., F.I.C., Sir Henry Trueman Wood, M.A., Secretary.

The following circular letter has been sent to those who are interested in the preservation of paper, with the object of obtaining information which may be of use to the Committee:—

Society of Arts,
John Street, Adelphi, London, W.C.,
August, 1897.

Dear Sir,—It has been brought to the notice of the Council of the Society of Arts that many books of an important character are now printed upon paper of a very perishable nature, so that there is considerable risk of the deterioration and even destruction of such books within a limited space of time. This is believed to be especially true of books which are in constant use for purposes of reference, and are therefore liable to much handling.

Although a great deal of investigation has been made into the subject in Germany, the matter appears to have attracted but little attention in this country. The Council, therefore, readily acceded to a proposal made to them, and appointed a Committee to inquire into and report upon the whole subject.

This Committee would feel very much indebted to you if you would tell them whether you have noticed any instances of books, published within the last thirty years, which already show signs of perishing, especially in the case of books which have been much used.

They will also feel much obliged if you will favour them with any other information which you think might assist the Committee, or with any suggestions which your experience might lead you to make.

Yours faithfully,
Henry Trueman Wood,
Secretary.

Proceedings of the Society.

HOWARD LECTURES

THE MECHANICAL PRODUCTION OF COLD.

By Prof. J. A. Ewing, M.A., F.R.S., M.Inst.C.E.

Lecture IV.—Delivered February 18, 1897.

Vapour Compression Machines; Choice of a liquid.

In the choice of a liquid for use as working substance in a compression machine there are several points to consider—some thermodynamical and some of a general practical kind. One of the first is the question of bulk, and the consideration of it may be said to put water at once out of court. The volume of 1 lb. of water vapour at 32° Fahr. is 3,416 cubic feet. Its latent heat is 1,092 thermal units. Hence the piston of a machine using water would have to sweep through something more than three cubit feet for each thermal unit of refrigeration, if the temperature of refrigeration is 32° Fahr. and still more if the temperature is lower. Compare this with the volume to be swept through when ammonia is used. Ammonia vapour at 32° Fahr. occupies about 4·8 cubic feet per lb., and its latent heat is 568 thermal units; hence the piston would in that case have to sweep through considerably less than one-hundredth of a cubic foot for each unit of refrigeration. With sulphurous acid for working substance the piston would have to sweep through about one-fiftieth of a cubic foot, and with carbonic acid barely one five-hundredth. In comparison with any of these this bulk of the water-vapour machine is excessive.

Another question to consider is what will be the working pressure of the two sides of the machine — the high-pressure side, A, and the low-pressure side, C. These pressures are determined by the temperatures of the condenser and refrigerator respectively. Their limits are fixed for any given vapour used as working substance when we are told what is the temperature of the water at which heat is rejected and what is the temperature at which refrigeration is to be performed. In the choice of a working substance one has to ask whether the pressures corresponding to these limits are either inconveniently high or inconveniently low. With water, they are excessively low; the vapour pressure of water is considerably less than one pound on the square inch even at the highest temperature likely to be reached on the warm side of a refrigerating machine. Sulphuric ether was at one time in favour as a natural working substance, but its vapour pressure is below the pressure of the atmosphere for all temperatures under 95° Fahr. Hence, in an ether machine both the high and the low pressure sides would be at less than atmospheric pressure, and any want of lightness would mean a leakage of air into the machine, not a leakage of ether out. This is a serious practical disadvantage, for the presence of air reduces the efficiency of the process. Besides, these ether machines were bulky, and the use of an inflammable vapour was objectionable. Modern machines use one or other of three substances, sulphurous acid, ammonia, and carbonic acid.

If we take a temperature of −4° Fahr. as a lower limit, that being about the lowest temperature at which refrigration is practically performed, we find that the pressure of the vapour in these three substances is for sulphurous acid about 9 lbs. per square inch, for ammonia about 21 lbs. per square inch, and for carbonic acid about 289 lbs. per square inch. If, again, we take 68° Fahr. as a representative upper limit at which heat is liable to be rejected (though sometimes as, for instance, in the tropics, we have to deal with a higher temperature) we find that sulphurous acid has a pressure of 66 lbs. per square inch, ammonia of 171 lbs. per square inch, and carbonic acid a pressure of 1,039 lbs. per square inch. On the diagram (Fig. 20) curves are drawn to show the vapour pressures of these substances in relation to the temperature. There the scale of temperature is given in Centigrade degrees, and the pressures are expressed, not in lbs. per square inch, but in atmospheres, each atmosphere being about 14·7 lbs. per square inch. You observe, then, that within the practical limits that I have just indicated the pressures of ammonia range from something like 20 lbs. to something like 170 lbs. on the square inch. These are just such pressures as engineers are accustomed to deal with in ordinary steam-engine work; they are pressures which present no serious difficulty as regards the keeping of joints and glands tight. With sulphurous acid the pressure is lower, and it falls below the pressure of the atmosphere when the temperature is anything under 14° Fahr. This exposes the low temperature side of the machine to the risk of air leaking in, which is then particularly objectionable, because it might produce sulphuric acid and corrode the metal.

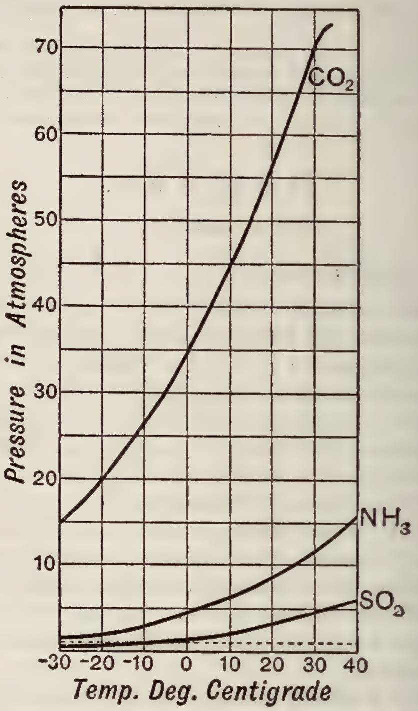

FIG. 20.—VAPOUR PRESSURES IN CARBONIC ACID, AMMONIA, AND SULPHUROUS ACID.

In vapour compression machines of any class leakage of the working substance out to the atmosphere is in general attended with no more serious disadvantage than that a portion of it is thereby lost, and has to be renewed from time to time, whereas leakage of the atmosphere into the machine means a diminution of the efficiency of the process, and in some cases it also means that chemical action is liable to go on between the working vapour and the oxygen of the air.

With carbonic acid, which is the third substance on our list, the pressures are greatly higher than in either of the other two. The volumes are correspondingly small, so that machines using carbonic acid have the advantage of great compactness in their working parts. But the keeping of joints and glands tight is a very much more serious mechanical problem in these machines, and even with the best construction and most careful use the loss of the working substance is much greater in them than in any others. On the whole, taking pressures as well as volumes into account, ammonia has the advantage over either of the other substances. The pressures that have to be dealt with are neither excessively high nor excessively low; and the bulk of an ammonia machine is moderate.

Other points to be considered are the cheapness and stability of the working substance, cheapness in regard to replacement as well as first cost, and stability in the sense of not being liable to chemical change through lapse of time, or through repeated passage round and round the cycle of operations. Again, it must not exert chemical action on the metal of the machine. Carbonic acid is without action on brass or copper as well as iron. Whereas ammonia, though without action on iron, is an active solvent of brass and copper, and these metals must, therefore, be entirely excluded from the machine and the coils, and all the parts of the working system when ammonia forms the working substance.

Again, we must always reckon on the possibility of leakage, though the probability is less with some substances than with others on account of differences in pressure; and it is important to enquire how far the working substance, should it leak, will be innocuous—how far it may be allowed to escape into a closed space without producing serious consequences. Another point is the facility of detection in the case of leaks. In this respect either of the other two substances has the advantage over carbonic acid, because of their smell. These are practical considerations, and the amount of weight to be given to any one of them will depend on the circumstances of the particular case.

But, in dealing with the relative merits of the various materials, there is still one important element which has to do with the thermo-dynamics of the subject. It has to do with the question—How far is one liquid more able than another to approach the thermodynamic ideal of efficiency? If we were dealing with the Carnot cycle of operations, it would be a matter of complete indifference which of the various liquids we employed, so far as thermo-dynamic considerations went, because in that case the efficiency would depend only on the limits of temperature, and would be unaffected by the properties of any particular working substance. But the case is different with the cycle which is actually used. That cycle differs from the Carnot cycle in the omission of adiabatic expansion and in the substitution of the throttle valve, through which the liquid is allowed to stream, for the expansion cylinder. Consequently, the liquid which streams through this valve into the refrigerator bring with it a certain quantity of heat. It is coming from a vessel at a relatively high temperature into a cold vessel, and brings with it the quantity of heat which is equal to the difference in temperature between the two multiplied by the specific heat of the liquid. In the refrigerator it takes up effectively a quantity of heat which depends upon the latent heat of the vapour. Hence the amount of the loss which results from omission of the expansion cylinder depends upon the proportion between the specific heat and the latent heat of the working substance.

To express this in figures, let r be the latent heat of the vapour, and let q_1 and q_2 be the amounts of heat contained in the liquid at the respective temperatures T_1 of the condenser and T_2 of the refrigerator. The heat which the liquid carries over is $q_1 - q_2$, which reduces the net refrigeration from r to $r - (q_1 - q_2)$, assuming the evaporation in the refrigerator to be complete. The quantity, $q_1 - q_2$, is equal to the specific heat of the liquid, multiplied by the difference of temperatures, $T_1 - T_2$. If we assume, as an example, that T_1 is 62° Fahr., and T_2 is 32° Fahr., the numbers for the various substances are as follows:—

—	Latent heat, r.	Liquid heat $q_1 - q_2$	Net refrigeration $r - (q_1 - q_2)$	Proportion of loss, namely, $\frac{q_1 - q_2}{r}$
Water........	1,092	30	1,062	$\frac{1}{36}$
Sulphurous acid	164	10	154	$\frac{1}{16}$
Ammonia	568	27	541	$\frac{1}{21}$
Carbonic acid..	100	16	84	$\frac{1}{6}$

Or take a case where the range of temperature is wider, and let T_1 be 68° Fahr., and T_2 be 14° Fahr., a similar calculation then shows that the loss due to the heat brought over in the liquid amounts with ammonia to 8½ per cent. of the gross refrigeration r, with sulphurous acid to 10½ per cent., and with carbonic acid to 29 per cent. With water the loss amounts to barely 5 per cent., but water, though best in this respect, is out of court for the reasons already given. Of the other substances, ammonia comes in this respect at the top of the list, and carbonic acid makes a bad third.

In other words, of the three substances ammonia gives us the least falling away from the ideal cycle of Carnot, and carbonic acid gives a relatively large falling away from that cycle.

ENTROPY DIAGRAMS FOR VAPOUR COMPRESSION MACHINES.

The working of machines of this class is most thoroughly grasped by the aid of the entropy diagram. Consider what is the form that this diagram will take for the working of a vapour compression machine. The entropy diagram is familiar to many persons in relation to the steam-engine, where we have an almost precisely reversed set of operations from those with which we are now dealing (Fig. 21). It may be useful to refer for a moment to the steam-engine cycle of operations before coming to the refrigerating cycle. In it we begin with the water delivered by the feed-pump to the boiler at the temperature of the feed, which is the lower limit of temperature. While the feed-water is being raised to the temperature of the boiler it is taking in heat, and this part of the operation is exhibited on the entropy diagram by a line that slopes upward, A D.

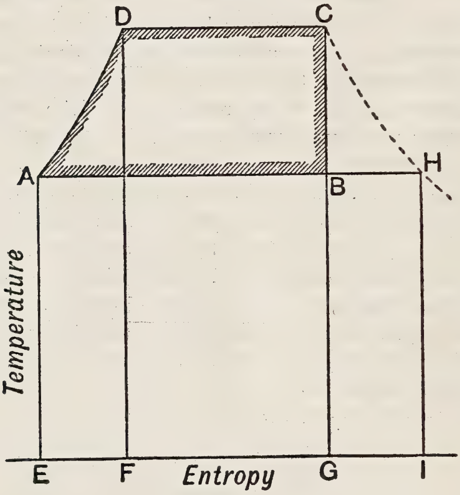

FIG. 21.

Remember that in the entropy diagram the heat taken in during any operation is represented by the area under the line which represents that operation. The heat taken in by the feed-water of the steam-engine while it is rising from the temperature of the feed to the temperature of the boiler is represented by the area E A D F. Then the line, D C, represents the evaporation of the water, and the heat taken in during that process is F D C G. It is at that time taking in heat without change of temperature, and hence the entropy line is parallel to the base. If we were to suppose a number of different temperatures at which evaporation might occur, and were to draw the corresponding line to D C for each of them, we should get a boundary line (passing through the extremities of all) of the kind represented by the dotted line C H. After the operation, D C, the next step is the expansion of the steam in the cylinder, and if we suppose the cylinder to be a non-conductor, so that the expansion is performed adiabatically, we have the line C B to represent this process, no heat being given out or taken in. Suppose the expansion to be continued until the steam falls to the temperature of the condenser. Part of the steam, namely, the fraction $\frac{BH}{AH}$ has become condensed during the expansion. The remainder is now condensed, this operation being represented by the line B A. In being condensed it gives out an amount of heat represented by the area G B A E.

Here we have the same cycle of operations as we have in the refrigerating machine, only performed the other way about. Trace the cycle in the order C D A B C, and it then represents the refrigerating process. The operation C D is the condensation of the compressed vapour. D A is the cooling of the condensed liquid as it passes into the refrigerator. A B is its evaporation there, and B C is the compression. Observe that if the vapour is only to be saturated, and not superheated, at the end of the compression, compression must begin at B and not at a point further out along the line B H. In other words the evaporation A B must be incomplete, leaving the fraction $\frac{BH}{AH}$ still unevaporated and mixed as liquid with the vapour when it enters the compression cylinder. In other words the refrigerator must *prime* to that extent if this vapour is not to become superheated by compression. In many cases superheating does take place, but it is only when the proportion of liquid to vapour in the mixture admitted to the cylinder is in the proportion of B H to A B that an adiabatic process of compression will have the effect of bringing the whole into the condition of saturated and dry vapour. The next process C D is performed in the condenser, and is the process with which we supposed the cycle to begin.

The area A E F D is the heat which is given to the refrigerator in consequence of the absence of an expansion cylinder; the net amount of refrigeration is the area A B G E *minus* the area A E F D. The question of efficiency as affected by the physical differences between any one working substance and another depends upon what relation the area A E F D bears to the area A E G B—that is to say, on the relation of $q_1 - q_2$ to $x\ r$, where x expresses the fraction which is vaporised before compression begins, or $\frac{\text{A B}}{\text{A H.}}$ The area of the closed figure A B C D measures the work that has to be expended in performing the cyle.*

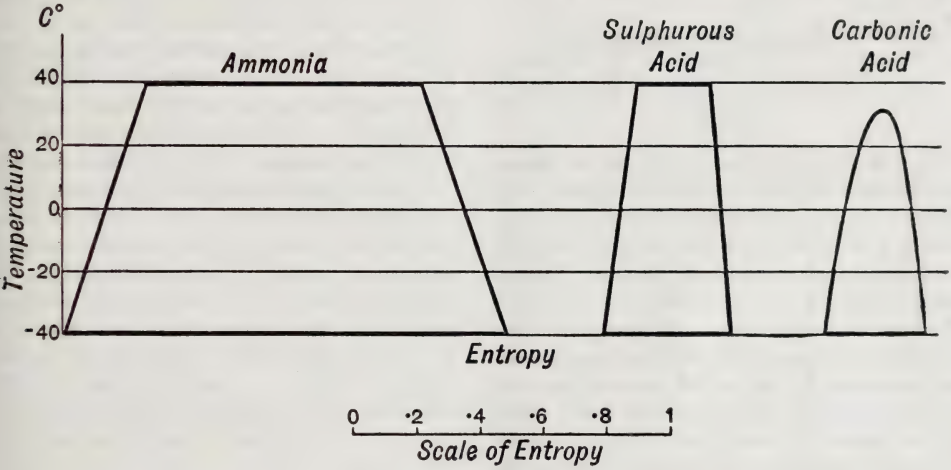

FIG. 22.

In Fig. 22 there are drawn to one scale the entropy temperature charts of ammonia, sulphurous acid, and carbonic acid. On the left in each diagram is the line taken by the substance in changing its temperature without being vaporised. On the right of each is a line corresponding to the dotted line C H of Fig. 21, showing the value of the entropy when the substance is completely vaporised at various temperatures. These figures bear out the conclusion come to before, that the absence of the expansion cylinder causes least loss of effect in ammonia and most in carbonic acid. In each case we have to distinguish between what may be called the gross refrigeration due to the evaporation of the liquid and the net refrigeration which is that quantity minus the area under the sloping line on the left-hand side. In the ammonia diagram the lines are as nearly as possible straight lines, and in the sulphurous acid diagram they are very nearly straight. The carbonic acid diagram has a rounded top at the critical temperature of the gas.

WET AND DRY COMPRESSION.

When compression is carried on in such a way that the vapour does not become superheated it is technically called wet compression. Wet compression is used in the Linde machines, and the regulating value is adjusted so that the compressor sucks in a mixture of vapour and liquid, with the result that the gas is still saturated at the end of the compression. By closing the regulating value a little the vapour passing over from the refrigerator may be made to contain less liquid mixed with it, and if it contains none the compression is said to be dry. In dry or partly dry compression the vapour becomes more or less superheated. An entropy diagram for ammonia using dry compression is sketched to scale in Fig 23.

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* The refrigeration cycle strictly is not strictly reversal of the steam-engine cycle, because the streaming of liquid through the regulating valve is not a reversal of the action of a feed-pump. To make the one a strict reversal of the other would require, so to speak, a negative feed-pump in the refrigerating machine — that is to say, a working cylinder which would get out of the liquid the equivalent of the work spent on the feed-pump. The work in question is $s\ (p_1 - p_2)$, where s is the volume of the liquid, and p_1 and p_2 are the pressures in the vessels A and C respectively. Hence the work which must be spent on the refrigerating machine with a throttle valve is really greater than the area, A B C D, by the amount $s\ (q_1 - q_2)$; and the net refrigerating effect is less by the same amount, being $x\ r - (q_1 - q_2) - s\ (p_1 - p_2)$.

Refrigeration is there supposed to take place at 10° C., and condensation at 20° C. The line C K shows, in a general way, how the entropy of the ammonia gas changes when it is superheated under constant pressure, starting from the saturated condition at C. The point K is determined by the intersection of this line by the vertical line H K through H, which represents adiabatic compression. It is supposed here that the compression is perfectly dry; in other words, that the compressor takes in only dry vapour. Then A H represents the evaporation in the refrigerator, H K the compression, K C the cooling of the compressed gas from its superheated state to the temperature of the condenser, C D its condensation in the condenser, and D A the cooling of the condensed liquid as it passes over into the refrigerator. During compression the temperature rises in this example to about 80° C. This superheating enlarges the area of the diagram, and therefore increases the amount of work to be spent in working the machine. On the other hand, the refrigeration is now greater by the amount of the area under B H—measured down to the base line which would correspond to the absolute zero of temperature.

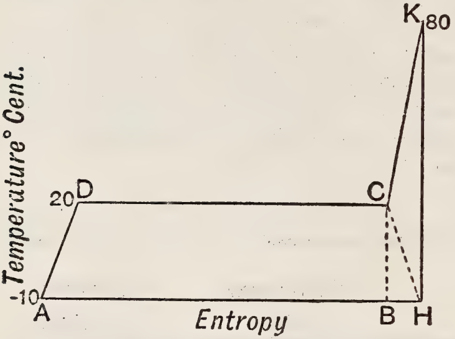

Fig. 23.—Ammonia Cycle with Dry Compressor.

An interesting question follows—how far does this modification affect the efficiency of the process, how far does it affect the ratio between the heat taken up in the refrigerator and the work done on the machine? Knowing the form of the lines in the entropy diagram, it is easy to calculate how much the ideal performance will be affected if we change from wet compression to dry, or to an intermediate kind, such as would be got by beginning to compress from some point between B and H. If you make this calculation, you will find, in the case of ammonia, that it makes no very substantial difference to the theoretical co-efficient of performance whether you make the compression wet or quite dry, or anything between the two. With the temperatures of condenser or refrigerator stated in Fig. 23 (20° C and — 10° C), I find that the dry process with the compression line H K makes the co-efficient of performance 8 per cent. less than the wet process with the compression line, B C. This comparatively small difference may seem surprising in view of the augmented range of temperature through which the substance is carried—its upper limit is now 80° C. But it must be borne in mind that the great bulk of the heat is still rejected during the condensation at 20° C, only a small quantity being taken from the gas at higher temperatures in cooling it down to the temperatures at which condensation occurs. If you take a compromise condition, where there is a smaller amount of superheating, the effect on the performance is of course less. If, for example, compression begins midway between B and H, so that the amount of superheating is about half of that indicated in the diagram, or 30°, the co-efficient of performance is only about 2 per cent. less than it is in the wet process, and if there were 15° of superheating, the reduction is barely one-half per cent. The moral of this is that so far as thermo-dynamic theory goes there is exceedingly little to choose between the perfectly wet process as it is approximately performed, for instance, in the Linde machine, and the more or less dry processes used by some other makers. I would emphasise this because claims of an extravagant kind are sometimes made in favour of one process or another in this respect. So far as thermo-dynamic theory is concerned there is little difference in the efficiencies of the wet and dry modes of compressing in ammonia machines. What little difference there is is in favour of the wet process as compared with any process involving considerable superheating. Strictly speaking, a very small amount of superheating is probably advantageous as compared with the absolutely wet process. It is only when we come to a distinctly high superheating that there is any material falling off in the co-efficient of performance. All these remarks, however, require this qualification, that in a real machine the process of compression is never adiabatic.

These calculations assume an adiabatic process, but in real cylinders there is always a give and take of heat between the working substance and the metal. It is by no means easy to say precisely how that effects the efficiency of the process. The exchanges of heat between the vapour and the cylinder will have the general effect of lessening the co-efficient of performance, and with dry gas the exchanges of heat will be less than they are with wet gas. Hence it is probable, on general grounds, that the loss of efficiency which such exchanges cause will be reduced somewhat by allowing a small amount of superheating, and Professor Schröter tells me that he has experimental evidence bearing out that conclusion. At most, however, we cannot expect much difference in efficiency between the wet process and one carried out in such a way as to produce some superheating, so far as ammonia is concerned. With carbonic acid, when the upper limit of temperature approaches the critical point, superheating is decidedly advantageous, and even necessary.

By help of the entropy diagram, or otherwise, we may estimate the theoretical performance in a cycle using wet compression, and compare it with the limiting performance in the perfect Carnot cycle.

I have worked out the figures approximately for ammonia and for carbonic acid, assuming the upper limit of temperature to be 20° C. or 68° Fahr., and taking various lower limits, ranging from 10° C. to — 20° C. The results are given in the Table below, along with the ideal co-efficient of performance in a perfect machine.

Theoretical co-efficients of performance in vapour compression machines, using wet compression, the upper limit of temperature being 20° C.

Lower Limit of Temperature.	Theoretical Co-efficient of Performance.		Co-efficient of Performance in Carnot Cycle.
Deg. C.	Ammonia.	Carbonic Acid.	
10	27·8	25·7	28·3
5	18·1	—	18·5
0	13·2	11·4	13·6
—5	10·2	—	10·7
—10	8·3	6·8	8·8
—20	5·9	4·5	6·3

The curves of Fig. 24 exhibit these results. It will be noticed that with ammonia the theoretical performance, namely, that of a compression machine without an expansion cylinder, is only a little less than the ideal performance which would be obtained by following Carnot's cycle. Hence with this substance we should gain almost nothing by adding an expansion cylinder to the machine, nothing, certainly, that would in any way compensate for the increase of complexity and friction and cost which an expansion cylinder would involve.

With carbonic acid there is considerably more falling away from the ideal of Carnot, for the reason which I have already explained, that the specific heat of the liquid bears a greater proportion to the latent heat of the vapour. But even then the saving in work which an expansion cylinder would bring about is not great, and in practice we never find the expansion cylinder, even in carbonic acid machines.

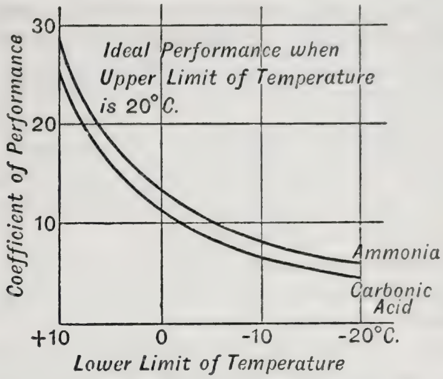

FIG. 24.—IDEAL PERFORMANCE IN VAPOUR COMPRESSION MACHINES WITHOUT AN EXPRESSION CYLINDER.

Both substances would give results falling more considerably short of the Carnot ideal if the upper limit of temperature were raised. This is notably true of carbonic acid. Say, for instance, that we have to deal with machines used on a voyage through the tropics. The condensing water may have a temperature of 90°, or even more. In that case not only would the ideal co-efficient be lower, but both machines would fall more short of it. The carbonic acid machine would fall in efficiency much more than the other, for carbonic acid is then in the neighbourhood of its critical point.

CARBONIC ACID AND THE CRITICAL POINT.

The critical point is the temperature above which the substance cannot be made to change from a gaseous to a liquid condition. In the entropy chart it is the temperature at which the boundary lines on the right and left meet if you extend them upwards. In any substance these lines are converging towards one another as the temperature is raised. Go on raising it, and you find that they bend towards one another, and finally meet in a continuous curve, giving the diagram a round top. This appears in the carbonic acid diagram in Fig. 22. At any temperature below the critical point there is a well-defined change of state between the liquid and the vapour, a change which is associated with the taking in of heat without change of temperature, but when the critical point is passed there is no such change. With ammonia or with sulphurous acid the critical temperature is so high that no account has to be taken of it in calculation relating to refrigerating machines which use these substances. But in the case of carbonic acid the critical point is comparatively low; it comes at a temperature about 31° C. or 88° Fahr., so that it comes within the range of temperatures that might have to be used in a machine working through tropical seas. The effect of approaching the critical point is to increase what we have called the liquid heat, namely, the heat that passes over in the liquid from the condenser to the refrigerator, in comparison with the latent heat that is taken up by evaporation in the refrigerator, and, consequently, to augment the loss which results from the absence of an expansion cylinder. The performance of carbonic acid falls off very materially when the condensing water is so warm as to approach this critical temperature, but the machine does not by any means cease to act as a refrigerator, even when the critical temperature is surpassed. It has been suggested that this might happen, but by arranging matters so that the gas is superheated during compression a respectable co-efficient of performance is maintained.

Thanks to the investigations of Dr. Mollier it is not difficult to estimate with precision what the theoretical performance of a carbonic acid machine will be under any particular conditions of temperature, and with any assumed degree of dryness in the vapour at the beginning of compression.*

Basing his calculations on the experiments of the French physicist, Amagat, who has investigated in great detail the physical qualities of carbonic acid, especially in the neighbourhood of the critical point, Dr. Mollier has drawn a complete entropy temperature chart for this substance, including the region above the critical point, and giving lines for the superheating of the vapour. Dr. Mollier's chart is reproduced in Fig. 25. The lines with numbers marked upon them are curves of superheating, each at a constant pressure, which the number states in kilogrammes per square centimetre. With the help of this chart it is easy to trace the entropy diagram corresponding to any assumed cycle, involving temperatures which lie above or below the critical point, and also involving any assumed amount of superheating. Inspection of the chart serves to show that when the condensing temperature is near 30° C., not only is dry compression advantageous, but if we were to attempt to prevent superheating, the net refrigerating effect would be *nil.* I cannot pass from the subject without a word of praise for these admirable investigations by which Dr. Mollier has cleared up some difficult points in the theory of refrigeration.

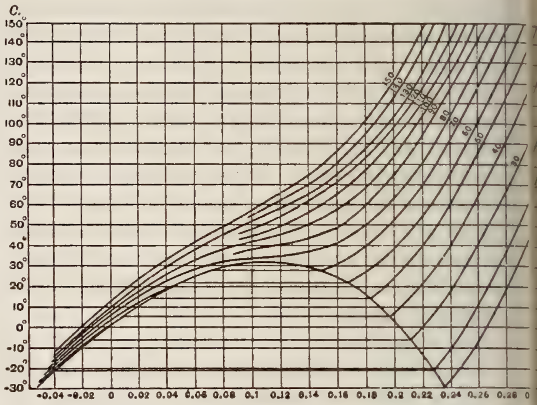

FIG. 25.—ENTROPY-TEMPERATURE CHART FOR CARBONIC ACID (MOLLIER).

HISTORICAL DEVELOPMENT OF THE VAPOUR COMPRESSION PROCESS.—PERKINS'S MACHINE OF 1834.

Leaving questions of theory, we have now to speak of the historical development of the vapour compression process, and of the modern forms taken by vapour-compressing machines. The process dates from 1834, when Jacob Perkins patented an apparatus, which is in all essential respects the same as the compression apparatus used at the present time. Sir Frederick Bramwell, in the *Journal* of this Society for December, 1882, has told the story of Mr. Perkins's experiments, in which he took part as an apprentice at the works of the engineer where the machine was built. He has told how with immense effort they succeeded on one occasion in producing a small piece of ice, which he immediately wrapped in a blanket and carried off in a cab to show to Perkins.

Fig. 26 is a sketch based on Sir Frederick Bramwell's description of the Jacob Perkins apparatus of 1834. P is the compressing pump with self-acting valves. The vapour is compressed into a coil of pipe forming a tubular condenser, W, which is surrounded by circulating water. From the condenser it passes in a liquid state through the loaded throttle valve, D, into a chamber formed by the space between the two bottoms of the freezing basin, A, where it is vaporised, and from which it returns to the compresser. We have here all the elements of the modern compression machine, and Perkins was no doubt warranted in making the wide claim which is stated in his patent. He claimed "The apparatus or means, as above described, whereby I am able to use volatile fluid for the purpose of producing the cooling or freezing of fluids, and yet at the same time constantly condensing such fluids, and bringing them again and again into operation without waste." The fluid he meant to use was sulphuric ether, but the experiments were made with a liquid produced by the destructive distillation of indiarubber, about which I can learn nothing definite beyond what Sir Frederick Bramwell has told me, namely, that it smelt abominably. It was the intention of Perkins to establish an ice factory in the River Thames by putting some of these machines in barges and driving them by paddles, which were to be turned by the ebb and flow of the tide.

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* R. Mollier, "Ueber die kalorischen Eigenschaften der Kohlensäure ausserhalb des Sättigungsgebietes." Zeitschrift für die gesammte Kälte-Industrie, Vol. III., 1896

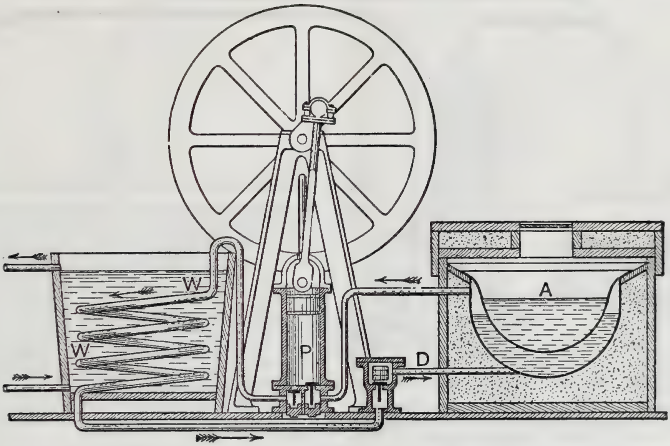

Fig. 26.—Vapour Compression Refrigerating Machine by Jacob Perkins, 1834.

As an inventor Jacob Perkins was in advance of his time. It was not until 1857 that the compression process came into commercial application. Then a machine using sulphuric ether was introduced by James Harrison, of Geelong. It is interesting to find a colonial taking this important step in the development of the process, and appropriate, for certainly no parts of the world have profited more from mechanical refrigeration than have the Australain colonies. On its introduction by Harrison the ether machine quickly came into considerable use, its manufacture being taken up in England by Messrs. Siebe and Gorman. But the ether machine is now obsolete. It had the drawbacks to which reference has already been made, that of the bulk was large in comparison with machines using other vapours, which came later into vogue. The pressure, both on the high and on the low pressure side, was considerably lower than the pressure of the atmosphere, consequently there was a tendency to the leakage of air inwards. Finally, the vapour of ether was highly inflammable. It was to take the place of an ether machine at the Bategate Works that Kirk invented his regenerative air machine, which I described in a former lecture, for the ether machine had produced a catastrophe, by the vapour leaking out, filling the room, and causing a conflagration.

SULPHUROUS ACID MACHINE.

The sulphurous acid machine dates from 1875, when it was introduced by M. Raoul Pictet. An example of it is shown in section in Fig. 27.

This machine is well-known in France and Switzerland, but is not much used elsewhere. Owing to the comparatively low vapour tension of sulphurous acid the construction differs in many points of detail from that of machines using ammonia or carbonic acid. The condenser, A, which is much like an ordinary marine condenser, consists of a group of parallel tubes set between two tube plates.

The compressed vapour is delivered through the pipe, D, to the space surrounding the tubes, while the cooling water, entering at L, circulates up through the tubes and down the annular space outside to the exit at M. The sulphurous acid passes in a liquified form through the regulating valve, K, to the refrigerator, C, which is built up of horizontal drums connected by vertical tubes, and is immersed in a tank of brine. In this example the brine is used to freeze water in cans, one of which is seen in section at H. The brine is kept in circulation by the screw G. The cylinder is furnished with a water jacket to keep down the temperature of the gas during compression. This makes a variation from the simple process of dry compression, which we occasionally find also in machines using other vapours. The gas is kept by the jacket from getting so hot as it would do if the compression were strictly adiabatic. Referring back to the entropy diagram, the effect of the water jacket is to bend this compression line backwards. Instead of being straight and vertical, as the line is for an adiabatic action, it is bent to the left as it rises, heat being taken away by the jacket during the compression. Hence the real compression line intersects the curve for superheating at a lower point than an adiabatic line would intersect it; in other words, the amount of superheating is less. A water jacket is generally used in the dry compression machines, whether the working substance is sulphurous acid or ammonia. In Pictet's machine, however, the water jacket extends not only round the barrel of the cylinder, but also through the interior of the piston and the piston-rod. The piston-rod is hollow, and communicates with the water jacket by means of two flexible pipes. A feature of these machines is the absence of lubrication, it being claimed that the working substance itself acts sufficiently as a lubricant of the cylinder and piston. In his refrigerating practice Pictet has used for working substance a special fluid, consisting mainly of sulphurous acid, but with the addition of about 3 per cent. by volume of carbonic acid.

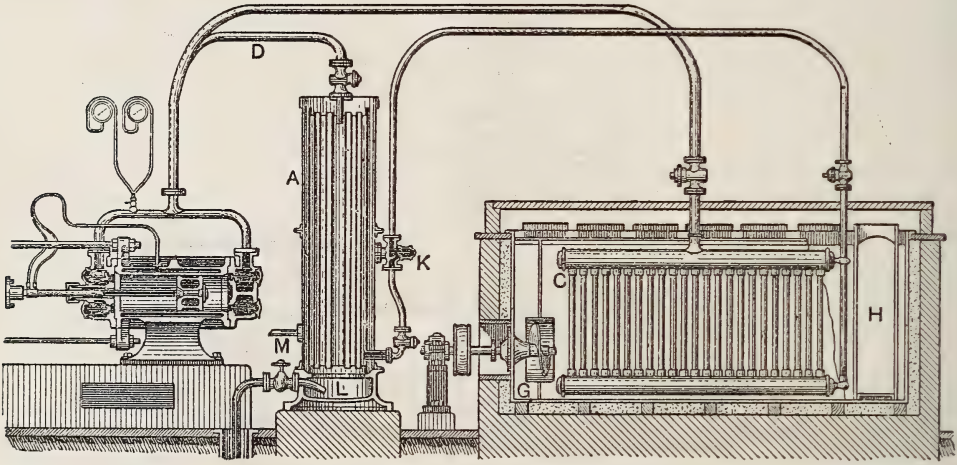

Fig. 27.—Pictet's Sulphurous Acid Machine.

Ammonia Machines.

The ammonia machine was introduced by Dr. Linde, then a professor at Munich, in the year 1876, and was brought into use in the following year. Its convenient range of pressure and its comparatively small bulk commend it to general acceptance, and, further, it has, as I have pointed out, a thermo-dynamic advantage, in giving a cycle which makes a closer approach to the ideal cycle of Carnot than is got with any of the other substances that are practically used. The design of the Linde machine has been carried out with conspicuous care, and it owes much of its great success to excellence in mechanical detail.

Fig. 28 shows in section a compressor of the characteristic Linde type. It is double-acting, with spring inlet and delivery valves at each end. The valves in the ends of the piston are so arranged as to make the clearance space particularly small—something like half of one per cent. of the volume swept through by the piston. This secures a nearly complete delivery

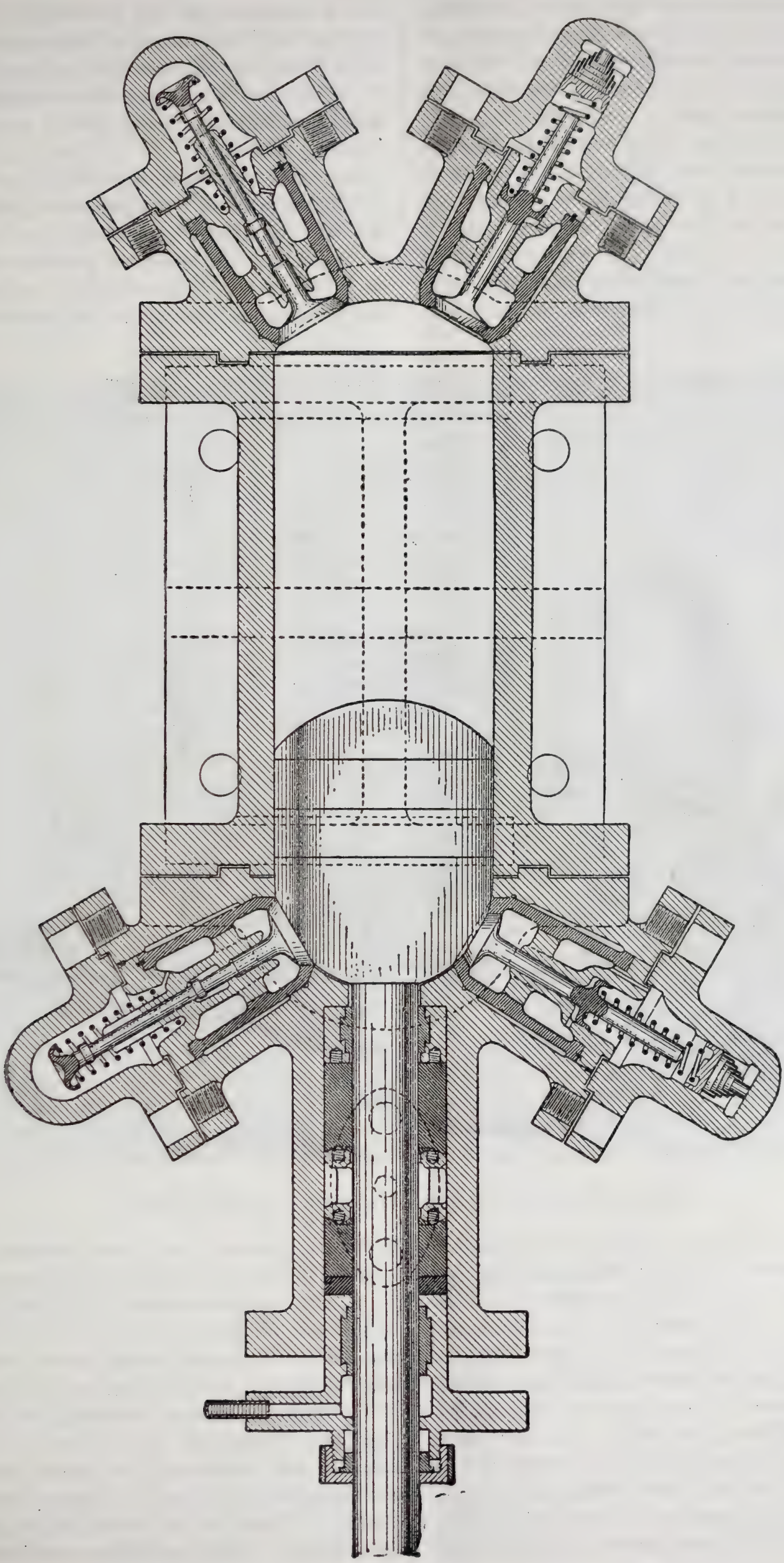

Fig. 28.—Compressing Cylinder of the Linde Ammonia Machine.

of the contents of the cylinder at each stroke. An interesting detail about these machines is the construction of the stuffing-box. To prevent escape of the ammonia the device is adopted which used to be called in steam-engines a lantern brass. The packing is divided into two parts, with a hollow space in the middle, and the space is in this example connected by a pipe with the suction side of the machine. Hence any ammonia which leaks through the inner part of the packing is carried away to the suction side, and not lost, and the outer part of the packing is exposed to no more pressure than the difference between the pressure on the suction side and that of the atmosphere. Any leakage to the outside depends upon that difference of pressure, and not on the much larger difference of pressure which exists between the compression side of the machine and the atmosphere. Another point of importance is the lubrication. Oil is forced in through a hollow in the gland, and spreads itself over the surface of the piston-rod. No more oil is used than is required for the lubrication of the piston-rod. In this respect the Linde machine differs from some other examples of ammonia machines, in which oil is injected into the cylinder and allowed to mix in considerable quantity with the working vapour.

Even here, however, there will be some slight admixture of oil with the ammonia, and as it is desirable to remove the oil before the ammonia is condensed, in order to prevent a deposit which would interfere with the activity of the condensing surfaces, an oil separator is used in the larger size of the Linde machine. This is an upright vessel, through which the ammonia from the compressor passes, depositing in the bottom any oil that it brings over. The oil is drained into a second vessel below, which is exposed to the suction pressure only, so that most of the ammonia contained in the oil evaporates before the oil is drawn off. The machine and all parts of the system are made of iron and steel, no brass or copper being permissible. There is no water jacket, for wet compression is used, and the ammonia when it

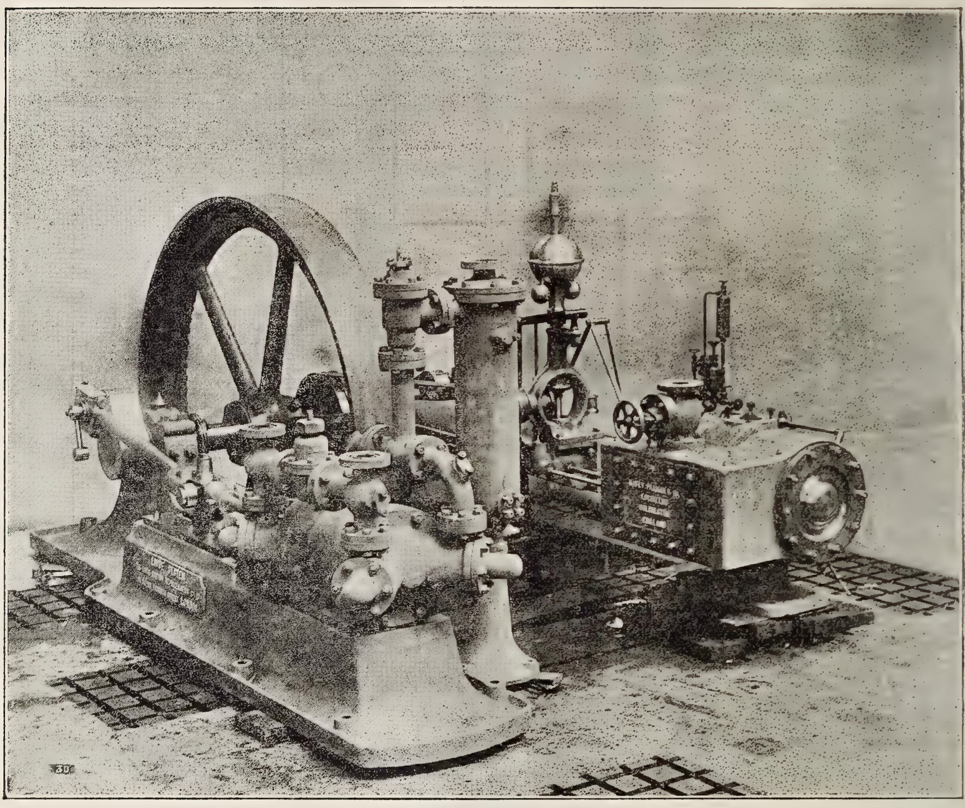

Fig. 28a.—Linde Ammonia Machine. Marine Type.

leaves the cylinder is cool. Linde usually makes his compression cylinder horizontal, except in the smallest sizes; the steam cylinder is also horizontal, and drives on a crank set at right angles to the crank of the compressor. This form is preferred to the tandem arrangement of steam and compression cylinders, on the ground that it gives a more uniform crank-effort. With the tandem arrangement the steam-pressure is least where the compressor pressure is greatest.

A typical example of the Linde machine is shown in Fig. 28A. As made for marine use, the compressor is occasionally compound, the process of compression being conducted in two successive stages.

In another form of large machine, a compound horizontal steam-engine is used along with two parallel compressors, each steam cylinder being set tandem with one compressor cylinder. The success achieved by Dr. Linde may be judged from the fact that his companies in England, on the Continent of Europe, and in America, have sold about 3,000 machines, with an aggregate refrigerating capacity of over 60,000 tons of ice daily.

Other ammonia machines, more or less closely resembling these, are made by the Kilburn Company, by the Pulsometer Company, and by Messrs. Haslam. In America there are a host of manufacturers of such machines. Some follow Linde without much variation; others adopt a drier method of compression, as for instance the De la Vergne machine, which has a great vogue in the United States, and has also met with considerable success in England in the hands of Messrs. Sterne. This presents a number of interesting points of difference from other ammonia machines, the most characteristic one being the amount of oil injected into the cylinder. The cylinder is vertical, and the clearance spaces, which are comparatively large, are filled with oil. The piston works down into a bath of oil at the bottom of the cylinder. The oil passes through a valve in the piston on to the top, and when the piston rises it carries the oil up with it, forcing it against a moveable head at the top of the cylinder, which rises to let the oil escape. Fig. 29 is a section through a De la Vergne compressor. In this case the compressor is single acting, the lower end of the cylinder being permanently in connection with the suction side of the machine, but double-acting compressors are also used. The oil in this sytem claims to serve four functions; it lubricates, it seals the gland, the valves, and the piston rings, it gets rid of the effects of clearance, and to some extent it cools the ammonia during compression, much as a water jacket would do, preventing the temperature from rising so high as it would rise if the compression were adiabatic. The ammonia is, however, considerably superheated.

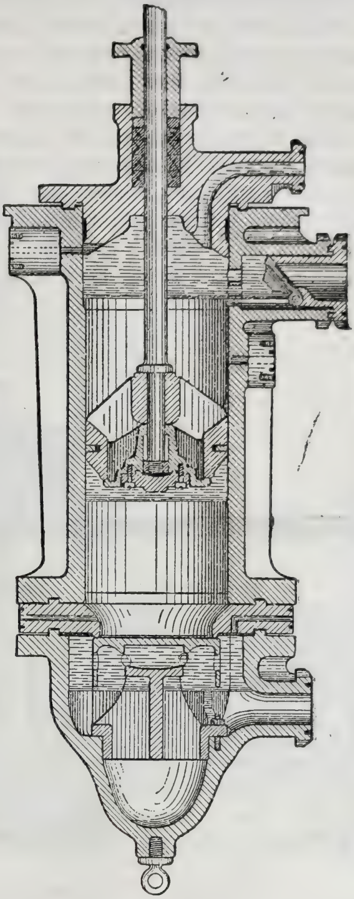

FIG. 29.—SINGLE-ACTING DE LA VERGNE COMPRESSOR.

The avoidance of clearance is scarcely perfect, for oil left in the clearance space, being more or less absorbent in regard to ammonia, gives off a certain amount of ammonia gas during the return stroke, when the pressure is reduced.

The De la Vergne compressor is carried on a frame vertically above the crank, and the steam cylinder is horizontal. The diagram, Fig. 30, is a complete view of the De la Vergne apparatus, including the condenser.

This is an example of a form of condenser which is in use by practically all the makers of refrigerating machines. Instead of taking the form of a coil submerged in a tank, the condenser is in the form of a group of pipes, arranged more or less horizontally in an open stack, and a fine stream of water is caused to drip over them, while the whole is exposed to the free access of air. This is the atmospheric or open form of condenser; it is often used in preference to the submerged condenser, because it uses very much less water. The condensing water here absorbs heat not simply by rising in temperature, as it does in a submerged condenser, but by evaporating, and the latent heat of water is so large that the amount of water required is a mere fraction of that which would be required to circulate through a condenser of the submerged type. The condenser in this example is divided into a number of sections, from which the ammonia drains into a storage tank, whence it passes through a regulating valve to the refrigerator. The refrigerator in Fig. 30 is made up of a series of pipes, placed in the room which is to be kept cold. The ammonia expands in these pipes, taking heat directly from the surrounding atmosphere of the room. This direct expansion, as it is called, is a usual feature in the De la Vergne plant. To aid the expansion pipes in taking in heat from the air their surface is increased by a number of cast-iron discs, but the advantage of these is probably slight after the pipes become coated, as they quickly do, with frozen moisture from the air. The oil, which is a characteristic feature in this machine, passes from the compressor to a separating tank, and to a cooler, which is arranged in much the same way as the condenser, in the form of a stack of pipes with dripping water. After being cooled the oil is again injected into the cylinder. There is thus a continuous circulation of oil as well as of ammonia.

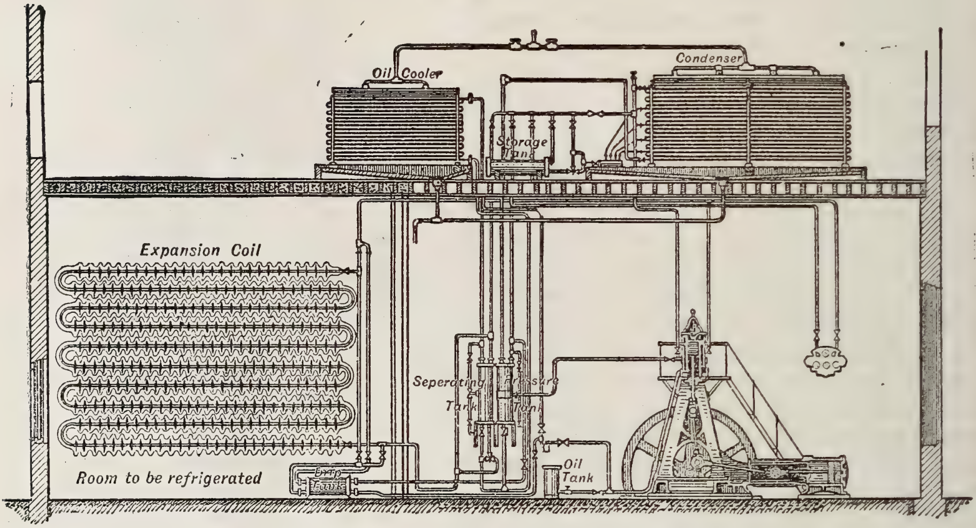

FIG. 30.—GENERAL VIEW OF DE LA VERGNE APPARATUS.

There is no question that these machines work exceedingly well, but I am not prepared to say that the excellence of their working is due to the oil circulation. It is difficult, on any ground of thermo-dynamic or other theory, to suggest a reason for expecting any marked advantage to result from this oil circulation, and there is no doubt, on the other hand, that it leads to a material increase in the complexity and cost of the apparatus.

CARBONIC ACID MACHINES.

One type of vapour-compression refrigerator remains to be spoken of. Carbonic acid machines were patented by Raydt in 1881, and by Windhausen in 1886. It is proper to mention that Professor Linde was one of the first, if not the very first, to introduce carbonic acid practically as a medium of refrigeration. In 1882 he supplied to Krupp's firm, at Essen, a carbonic acid machine, but he preferred ammonia on thermo-dynamic and other grounds. The carbonic acid machine is particularly associated with the name of Windhausen. His patents were taken up in England by Messrs. Hall of Dartford, who have successfully faced the difficult mechanical problems involved in the cyclical compression, without serious loss, of a substance which reaches a pressure of over 1,000 lbs. on the square inch. The carbonic acid machine has become in their hands a thoroughly practical means of refrigeration, and is specially used on board ship for the transport of chilled and frozen beef. The high pressures make it necessary to adopt arrangements that are considerably different from those adopted in ammonia machines. Figs. 31, 31A give sectional views of the cylinder of a carbonic acid compressor by Messrs. Hall. The piston rod is packed by two cup leathers, no other form of packing serving sufficiently to keep the gas from escaping, and similarly the stuffing-box is also packed with a pair of cup leathers, and the space between them—the lantern of the stuffing-box—has glycerine compressed into it, which serves as the lubricant. The glycerine is continuously forced into the lantern at a pressure higher than the highest pressure reached by the carbonic acid. Consequently the glycerine is continuously leaking in small quantities into the cylinder through the inner cup leather, a small quantity of glycerine also leaks out through the outer cup leather; but this device secures that the leakage shall be a leakage of glycerine, and not (mainly at least) a leakage of carbonic acid. The glycerine is forced into the lantern by means of a differential piston on the smaller side of which is glycerine while the larger

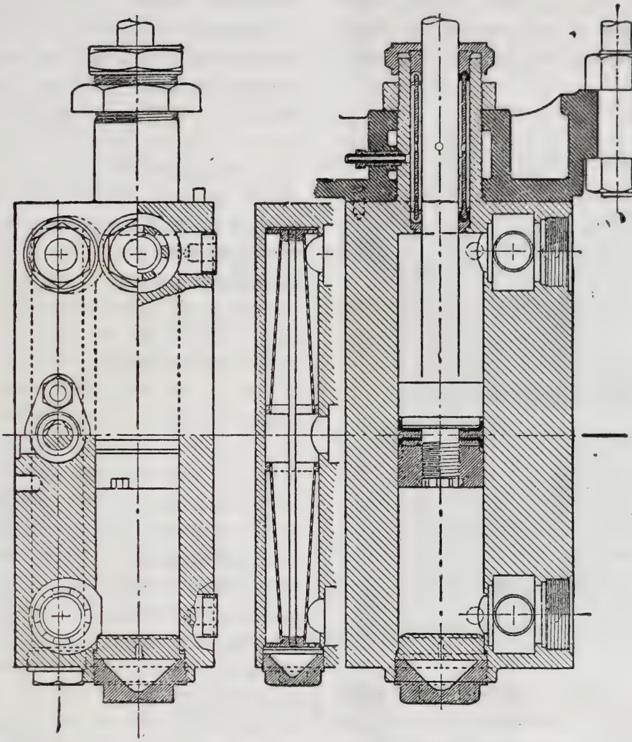

FIG. 31.—SECTIONS THROUGH HALL'S CARBONIC ACID COMPRESSOR.

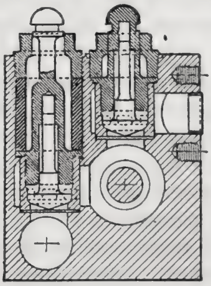

FIG. 31A.

side is exposed to the full pressure of the gas. The small volume of the compressing cylinder make these machines exceptionally compact. A small carbonic acid machine for marine use is shown in section in Fig. 32. The steam-cylinder and the compressor are arranged vertically side by side on a casting containing the condenser coils. These are of copper, and behind is another tank containing the evaporator coils, over which a circulation of brine is maintained. In front of the compressor in the drawing is a separator which serves to extract the glycerine from the compressed gas.

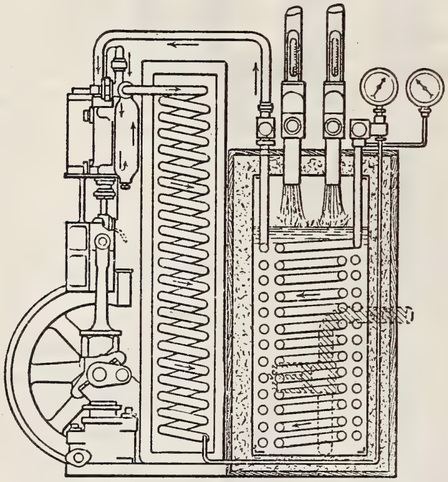

FIG. 32.—SMALL CARBONIC ACID MACHINE (HALL).

In small carbonic acid machines the compressor is made out of a gun-metal casting, but in larger forms it is bored out of a solid ingot of steel, cast-iron being unavailable for this purpose, because its porosity does not allow it to stand the high pressures to which these machines are subject. A single steel ingot is cut in two to form two compressor cylinders, and thus the porous central portion of the ingot is avoided.

In the larger machines a pair of compressors are set horizontally, one in tandem with each of the cylinders of a horizontal compound steam-engine. In some the engine is triple, the high and intermediate cylinders being on one rod and the low on the other.

In none of these machines is there an expansion cylinder. The thermo-dynamic gain, if we had one, would, as we saw, not be very great, and a point which I did not mention is that the ratio of volumes swept through by the compressor piston on the one hand, and by the expansion piston on the other hand, would have to depend upon the particular temperatures of the refrigerator and the condenser. It would not be the same when these temperatures varied, and, consequently, in order to get the full advantage derivable from the use of an expansion cylinder, it would be necessary to have some means of altering the relative speed of the expansion and the compressor pistons, and that, of course, would introduce very considerable additional mechanical complexity. Mr. Windhausen tells me that he has often urged on manufacturers to add an expansion cylinder, but it is scarcely surprising that it is not done.

In addition to the various types of machines which we have reviewed, there is a curious compromise type of machine, midway, as it were, between the absorption type and the compression type. This is a machine which has been developed by Osenbrück. He employs what is essentially an absorption machine, but with the addition of a compressor cylinder, which inhales the vapour of the ammonia from the refrigerator, and compresses it to a considerably higher pressure before it is absorbed. In other words, instead of having the pressure in the absorber equal to the pressure in the refrigerator, which is the usual arrangement in an absorption machine, Osenbrück produces a step-up in pressure between the refrigerator and the absorber, the step-up being effected by the agency of a compressor cylinder. I have not heard whether this principle has found much application; it seems not unlikely to share the fate which generally attends compromises.

International Congress on Technical Education.

WEDNESDAY, 16TH JUNE.

SECTION A.

RAPPORT SUR L'ENSEIGNEMENT TECHNIQUE EN BELGIQUE.*

PAR PAUL WAUTERS,

Inspecteur-Adjoint de l'Enseignement Industriel et Professionnel, délégué du Gouvernement Belge.

M. Rombaut, Inspecteur-Général de l'Enseignement industriel et professionnel, avait été délégué avec M. le Professeur Pyfferoen,

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* This paper was not in hand when the Report of the Meeting of June 16th was printed in the *Journal*. See *ante* page 804.

ici présent, et moi, pour représenter officiellement le Gouvernement belge au Congrès international de l'Enseignement technique organisé à Londres par votre importante Société.

M. Rombaut avait l'intention de prononcer un discours pour faire l'historique et vous donner le détail de l'enseignement technique tel qu'il est organisé en Belgique. Une indisposition l'ayant empêché au dernier moment de partir pour l'Angleterre, je me trouve appelé à l'honneur enviable mais périlleux, de le remplacer. L'important auditoire devant lequel j'ai l'avantage de me présenter perdra certainement au change ; je ne suis pas orateur, et ayant été pris au dépourvu, je me vois forcé de réclamer toute sa bienveillante indulgence.

Je me bornerai à présenter un résumé sommaire de la question et je serai trop heureux de pouvoir fournir, ensuite, des renseignements complémentaires à toutes les personnes qui voudraient bien en demander.

L'enseignement technique dépend en Belgique du Ministère de l'Industrie et du Travail. Monsieur le Ministre Nyssens qui dirige ce Département depuis plus de deux ans avec une autorité reconnue par tous les partis, pénétré de ce qu'un des principaux moyens de faire progresser l'industrie, est de relever la valeur intellectuelle et morale de ceux qui la pratiquent, a donné une impulsion nouvelle à cette question, si importante pour la prospérité du pays et le relèvement du travailleur. Il favorise, par tous les moyens en son pouvoir, la création d'institutions nouvelles et le développement de celles qui existent déjà. Le Gouvernement accorde aux écoles son concours financier, mais en retour il se réserve le droit d'approbation des règlements, des programmes et des horaires des cours, des budgets, ainsi que des nominations des membres des Commissions administratives et du personnel enseignant. Un service d'inspection, dirigé depuis de longues années par M. l'Inspecteur-Général Rombaut, a pour mission de contrôler la marche des écoles et d'aider à leur perfectionnement.

Je vais me permettre, si vous le voulez bien, de donner un rapide aperçu des divers genres d'établissements d'instruction subsidiés en Belgique par le Ministère de l'Industrie et du Travail. Je les ai divisés de la manière suivante :

I.—Enseignement ménager pour jeunes filles;

II.—Enseignement professionnel pour jeunes filles ;

III.—Ateliers d'apprentissage pour jeunes filles et pour garçons ;

IV. — Enseignement professionnel pour garçons ;

V.—Enseignement industriel pour garçons ;

VI.—Ecoles spéciales pour garçons.

I.—ENSEIGNEMENT MÉNAGER POUR JEUNES FILLES.

La Belgique ne comptait que deux institutions de ce genre il y a dix ans et elle en a aujourd'hui 225 dirigées par 450 maîtresses et fréquentées par 9,539 jeunes filles. Si ces écoles ont pris un tel développement, c'est parce qu'elles rendent des services inappréciables aux classes laborieuses.

On croirait peut-être à l'étranger qu'il s'agit ici de grands établissements destinés à former des demoiselles à l'esprit bien cultivé, non. L'enseignement ménager poursuit un but plus modeste : il s'adresse à la fille de l'ouvrier, il l'initie à la pratique raisonnée des travaux du ménage et lui fait acquérir les vertus domestiques qui lui seront nécessaires quand, à son tour, elle fondera une famille nouvelle.

La premiére école ménagère fût créée en 1872 à Couillet, la seconde en 1874 a Frameries, d'autres vinrent après, mais faute de surveillance et de programme bien défini, presque toutes se transformèrent peu à peu en écoles de couture. Leur organisation, telle qu'elle existe aujourd'hui, et leur prospérité, datent de 1889. (Circulaire Ministérielle du 26 Juin 1889.) Depuis cette époque, l'enseignement ménager est subsidié par le Gouvernement. La fondation des écoles cependant, est laissée, comme autrefois, à l'initiative privée, aux sociétés charitables et aux communes. Le but poursuivi est resté le même : donner aux jeunes filles de la classe laborieuse toutes les connaissances que doit posséder une bonne ménagère.

Les cours se font le matin, l'après-midi, le soir ou le dimanche, suivant les besoins locaux. L'enseignement est de une ou deux années, d'après l'importance des institutions et le nombre de jours de cours par semaine ; les établissements sont appelés suivant les cas : écoles ménagères ou classes ménagères. Chaque école n'a, en moyenne, qu'une vingtaine d' élèves, à l' exception de certaines institutions des centres populeux qui en comptent un nombre notablement plus grand. Le programme des écoles ménagères comprend des cours théoriques et des exercices manuels.

A.—Les cours théoriques comportent.

1°. Des notions d'hygiène,

2°. L'économie domestique,

3°. Les soins à donner aux enfants et aux malades.

B.—Les exercices pratiques sont.

1°. La cuisine et le ménage ;

2°. La couture, le raccommodage du linge et des vêtements et le tricotage ;

3°. Le lavage et le repassage du linge ;

4°. L'entretien des meubles et des habitations ;

5°. Enfin, pour les communes rurales, les travaux du jardin potager et les soins de la basse-cour.

Les élèves sont divisées en groupes ; ceux-ci s'occupent alternativement des travaux signalés et constituent, autant que cela peut se faire, un véritable ménage ouvrier, où chacune remplit à son tour les fonctions de la ménagère.

On peut juger par cet exposé succinct, du rôle social puissant que l'enseignement ménager pour jeunes filles exerce dans la société. Il forme pour l'ouvrier des ménagères intelligentes, économes, soigneuses et dévouées, des femmes capables de lui donner un intérieur heureux et agréable, et de lui faire apprécier la vie de famille qui sauve de l'alcoolisme et est une des bases de la société.

II.—Enseignement Professionnel pour Jeunes Filles.

Ces institutions, d'une très grande utilité, ont produit, dès leur création, d'excellents résultats.

Les unes ont été organisées par l'initiative privée, d'autres par les Communes. Le but poursuivi est de donner à la femme les connaissances générales qui lui sont necessaires, en développant l'instruction reçue à l'école primaire, et de l'initier en même temps à la pratique d'un métier en la soustrayant à l'influence, souvent funeste, de l'atelier.

De là deux espèces de cours : des leçons générales que toutes les élèves doivent suivre et des cours spéciaux ou professionnels.

A.—Leçons générales.

Celles-ci comprennent, d'après les localités et l'importance de l'école, une plus ou moins grande partie des cours suivants : les langues française, flamande, anglaise et allemande, l'arithmétique, les sciences commerciales, l'histoire, la géographie, la calligraphie, les notions de sciences naturelles, de physique, de chimie, l'hygiène, l'économie domestique, la géométrie, le dessin, le chant, les connaissances pratiques des tissus, la pédagogie maternelle, la morale, &c.

B.—Cours spéciaux ou professionnels.

L'enseignement professionnel comprend à un degré plus ou moins développé suivant les écoles : la confection, la lingerie, les corsets, la coupe et le dessin appliqué, le dessin industriel, le dessin d'après nature, la peinture sur porcelaine, sur soie, sur métaux, sur verre, les fleurs artificielles, les modes, la broderie, le cartonnage, les travaux domestiques, la cuisine, le lessivage, le repassage, le raccommodage, l' entretien de l' habitation et du mobilier, l'histoire du costume, etc.

Les difficultés inhérentes à la création des écoles professionnelles pour garçons n'existent pas au même degré, pour les écoles professionnelles pour jeunes filles. La nature même des métiers qui conviennent à la femme n'entraîne pas à des dépenses aussi grandes et ne nécessite pas un matériel, ni une installation aussi importants.

Cet enseignement comporte actuellement 26 écoles, 242 professeurs et maîtresses, et 2,904 élèves ; elles coûtent annuellement 370,288 francs.

Les jeunes filles, ainsi instruites, deviennent non seulement habiles au point de vue professionnel, mais l'école leur inspire aussi l'amour du travail et de l'économie et forme une pépinière de jeunes femmes, capables, grâce à leur éducation, d'obtenir plus tard dans leur ménage une influence prépondérante et d'y faire régner l'ordre, l'aisance et le bonheur.

III.—Ateliers d'apprentissage pour Jeunes Filles et pour Garçons.

Ces établissements sont de genres assez divers, mais ils ont tous un but semblable : celui de perfectionner le jeune apprenti dans la pratique d'un métier facile qui pourra être exercé ensuite à domicile et au moyen d'outils peu coûteux.

Pour réaliser ce but, des contremaîtres instructeurs sont chargés de l'instruction professionnelle des élèves. Ils leur apprennent le métier dans tous ses détails et ses derniers perfectionnements, ils indiquent le montage et l'entretien des outils utilisés et enfin ils complètent ces leçons par des notions pratiques de la théorie des branches d'industries exercées dans l'atelier.

Pour permettre à ces jeunes ouvriers qui ont généralement reçu une instruction assez sommaire, de retirer tous les fruits désirables de cet enseignement technique, on entretient leurs connaissances primaires, et on les complète même dans certains ateliers par des cours spéciaux, tels que le dessin, la mécanique, etc. Toutes les leçons, tant théoriques que pratiques, se donnent le jour.

Les ateliers d'apprentissage étaient, à l'origine, des établissements purement communaux, mais depuis 1841, des subsides ont été accordés par les provinces et par l'Etat. Le travail se fait, en général, pour le compte d'industriels qui fournissent la matière première. Chaque atelier est dirigé par une Commission comprenant ordinairement trois membres renouvelés périodiquement et nommés par les divers pouvoirs qui interviennent au budget.

Les ateliers d'apprentissage sont actuellement au nombre de 55 ; ils se répartissent de la manière suivante: 31 ateliers de tissage, 11 écoles professionnelles de tissage, 11 ateliers pour la taille des pierres, tous pour garçons; 1 atelier pour le tressage de la paille et 1 atelier de coupe des vêtements et de couture pour jeunes filles. Ils comptent 60 professeurs ou contremaîtres et 1,158 apprentis.

Ces institutions ont déjà rendu d'immenses services et sont encore aujourd'hui très prospères, surtout celles pour la taille des pierres. Leur importance, en ce qui concerne le tissage, diminue dans certaines localités, par suite du developpement du travail mécanique.

IV.—ENSEIGNEMENT PROFESSIONNEL POUR GARÇONS.

Cet enseignement comprend des écoles professionnelles, des cours professionnels, des cours commerciaux et des cours scientifiques.

L'école professionnelle et l'école industrielle poursuivent des buts distincts. Dans l'idée du Gouvernement, la première, sans négliger d'inculquer au futur ouvrier les connaissances théoriques qui peuvent lui être utiles dans l'exercice de sa profession, doit avoir surtout en vue de lui enseigner la pratique de son métier, en un mot, de former l'ouvrier. L'apprentissage à l'atelier est devenu en général défectueux et incomplet ; l'école doit y remédier en développant l' aptitude professionnelle. Elle doit donner à l'apprenti les connaissances techniques et pratiques dont il a besoin pour arriver à la perfection du travail. L'enseignement professionnel doit rendre la production meilleure en vulgarisant les procédés faciles et les méthodes les plus avantageuses. Ainsi compris, il ne peut manquer de faire augmenter la production, de l'améliorer et par ce fait, de relever le salaire.

Les écoles professionnelles ont des origines diverses ; un grand nombre d'entre elles sont dues à l'initiative privée et à des syndicats professionnels.

Leur organisation diffère suivant les besoins locaux et le but spécial poursuivi. Les unes sont payantes, d'autres gratuites. Les cours se donnent parfois le soir et ont seulement en vue de perfectionner l'apprentissage qui se fait alors en réalité pendant le jour à l'atelier privé ; d'autres fois, les leçons ont lieu le jour et poursuivent un apprentissage complet à l'école. Pour bien faire voir l'organisation de ces établissements, il faudrait donner l'historique détaillé de chacun d'eux, ce qui n'entre pas dans le cadre de cet exposé sommaire.

Qu'il me suffise donc d'énumérer les divers genres d'écoles et de cours professionnels, subsidiés en Belgique par le Gouvernement :

1°. Des écoles professionnelles pour le travail du fer et du bois, à Gand et à Tournai ;

2°. D' horlogerie, d'électricité et de petite mécanique, à Bruxelles ;

3°. De bijoutiers et ciseleurs, à Bruxelles ;

4°. De tailleurs, à Bruxelles et à Liége ;

5°. De tapissiers-garnisseurs, à Bruxelles ;

6°. De typographes, à Bruxelles ;

7°. D'armurerie, à Liége ;

8°. De métiers divers, à Louvain et à Oostacker ;

9°. De pêche, à Ostende, à Blankenberghe et à Nieuport ;

10°. Des écoles St. Luc, qui préparent les jeunes gens par le dessin professionnel aux divers métiers d'art appliqué à l'industrie, à Gand, à Bruxelles, à Liége et à Tournai ;

11°. Des cours de dessin professionnel, à Anvers et à Herve ;

12°. Des cours de peinture professionnelle, à Audenarde ;

13°. Des cours de langues et des cours commerciaux, à Liége, à Anvers, à Bruxelles et à Gand ;

14°. Des cours publics scientifiques, à Bruxelles.

Soit un total de 23 institutions différentes, comptant 144 professeurs et 3,301 élèves, alors qu'il y a dix ans ils n'y en avait que 7 avec 33 professeurs et 459 élèves.

Comme on vient de le voir, l'enseignement professionnel pour garçons embrasse un grand nombre des métiers exercés dans le pays ; il est donc très utile, mais d'organisation coûteuse et difficile. Il prospère lentement et sûrement et plusieurs écoles nouvelles sont encore en ce moment en formation, notamment une école professionnelle de coiffure.

V.—ECOLES INDUSTRIELLES POUR GARÇONS.

Le but recherché par le Gouvernement dans les écoles industrielles est de donner à l'ouvrier l'instruction scientifique qu'il ne peut acquérir à l'atelier, de développer son intelligence en l'initiant à la connaissance des lois générales qui président aux transformation de la matière, afin de le soustraire graduellement à la tyrannie de la routine et de lui procurer ainsi les moyens d'augmenter la valeur économique de son travail et d'améliorer, par cela même, sa condition matérielle.

Ces institutions, à une exception près, sont toutes communales. Elles sont subsidiées par les communes, par les provinces et par l'Etat.

La haute surveillance de chaque école est confiée à une Commission administrative, composée généralement du Gouverneur, du Bourgmestre et de 6 membres renouvelés pèriodiquement et choisis, deux par les conseils communaux, deux par la députation permanente des provinces et deux par le Gouvernement.

Les directeurs et les professeurs sont nommés et révoqués par les administrations communales sur l'avis des Commissions administratives. Ces nominations et révocations sont soumises à l'approbation du Ministre compétent.

L'instruction donnée dans les écoles industrielles est essentiellement théorique *et basée sur le dessin, dont l'enseignement marche toujours de pair avec la théorie;* plusieurs de ces institutions, cependant, ont organisé certains cours professionnels.

Toutes les leçons se donnent le soir ou le dimanche matin. L'enseignement se fait en flamand ou en français, d'après les régions. Dans certaines écoles les cours sont gratuits, dans d'autres les élèves doivent payer un droit d'inscription peu élevé. Cette mesure tend à se généraliser de plus en plus ; elle donne d'excellents résultats, car on apprécie généralement mieux ce qu'on doit payer.

Les études sont divisées en trois, quatre ou cinq années, d'après les institutions. Les deux premières années sont communes et comprennent des cours généraux utiles à tous ; à partir de la troisième année la division se fait et chaque élève suit un ensemble de leçons et d'exercices de dessin, en rapport avec sa profession ou ses aptitudes spéciales.

Les matières généralement enseignées dans toutes les écoles industrielles sont les suivantes : l'arithmétique, l'algèbre, la géométrie, la physique, la mécanique, l'hygiène, l'économie industrielle, le dessin à main levée, le dessin géométrique, les projections, la perspective et le dessin professionnel.

Outre ces branches générales, un grand nombre d'écoles donnent des cours spéciaux, en rapport avec les industries de la région, tels que : l'électricité, la chimie, la métallurgie, les machines à vapeur, le chauffage, l'entretien et la conduite des machines, l'exploitation des mines, la géométrie descriptive, la coupe des pierres, la construction civile, l'architecture, la construction navale, la trigonométrie et le nivelage, la théorie de la filature et du tissage, les langues, la comptabilité industrielle et commerciale, l'histoire, la géographie commerciale, le dessin d'ornement, etc.

Enfin, certaines écoles ont organisé des cours professionnels, à savoir : le modelage, la sculpture, le tissage, la teinture, la peinture professionnelle et décorative, etc.

L'aptitude des élèves est constatée avant leur admission à l'école ; ils doivent, en outre, passer un examen pour être admis d'une année d'étude à la suivante.

Des diplômes sont délivrés aux élèves qui achèvent leurs études et prouvent qu'ils possèdent les matières enseignées.

Toutes les écoles ont des collections scientifiques, des modèles industriels et des modèles de dessin qui permettent de rendre les leçons plus intuitives. Elles ont aussi une bibliothèque, des laboratoires et en général le matériel nécessaire à l'enseignement.

Les écoles industrielles sont au nombre de 40; elles comptent 466 professeurs, 13,015 élèves, et elles coûtent annuellement 657,763 francs.

L'enseignement industriel pour garçons donne d'excellents résultats et gagne encore chaque année en importance.

VI.—ECOLES SPÉCIALES POUR GARÇONS.

Les écoles spéciales pour garçons sont au nombre de six, subdivisées de la manière suivante :

1°. Une école supérieure de commerce, à Anvers ;

2°. Une école provinciale d'industrie et des mines, à Mons ;

3°. Une école supérieure des textiles, à Verviers ;

4°. Trois écoles de brasserie, dont deux établies à Gand et une à La Louvière.

L'enseignement donné dans ces institutions s'adresse à des jeunes gens ayant reçu une instruction préliminaire assez complète ; c'est ainsi qu'il peut être d'un degré plus élevé que celui donné dans les autres écoles techniques.

1°. *L'Institut supérieur de Commerce d'Anvers* a pour but de fournir aux jeunes gens qui se destinent aux affaires commerciales et aux carrières consulaires, le complément de l'instruction commencée dans les établissements d'enseignement moyen. La pratique ne suffit pas pour faire un commerçant accompli, il faut aussi la théorie ; l'école d'Anvers la donne à ses élèves et forme ainsi, tant pour le pays que pour l'étranger, des consuls, des négociants, des comptables, des employés, capables de remplir leurs fonctions avec honneur ;

2°. *L'Ecole provinciale d'industrie et des mines de Mons* fut une des premières institutions créées en Belgique pour préparer aux professions industrielles. Elle ne visait au début qu'à fournir aux exploitations des mines et aux usines métallurgiques, des jeunes gens convenablement préparés, par de hautes études, à la direction de ces importantes industries. L'ecole s'est développée, depuis quelques années surtout, et elle forme aujourd'hui des ingénieurs aptes à diriger avec fruit tous les genres d'établissements industriels.

3°. *Ecole supérieure des Textiles à Verviers.*—Il existe depuis longtemps, à Verviers, une école professionnelle pour garçons, ayant adopté comme spécialité le tissage et tout ce qui se rapporte à cette industrie, d'un si grand intérêt local. Les cours sont simples, à la portée des ouvriers, et visent surtout à former de bons contremaîtres.

La création d'une Ecole supérieure des Textiles, annexée à l'Ecole professionnelle, fut décidée en 1891 et, grâce à la généreuse intervention des industriels, elle put s'ouvrir en 1894 ; elle vise surtout à la formation de bons chefs d'établissements industriels de textiles.

L'Ecole supérieure de Verviers est encore de création trop récente pour qu'on puisse juger d'une manière définitive les résultats obtenus, mais la marche favorable des études permet d'en attendre de réels services.

4°. *Ecoles de Brasserie.*—Ces écoles sont actuellement au nombre de trois ; la plus ancienne est l'Institut supérieur de brasserie établi rue de Bruges, à Gand. Elle a été créée en 1887 par un Syndicat de brasseurs ; la seconde est annexée depuis 1894 à l'Institut St. Liévin, à Gand, et la troisième, de création nouvelle, à l'Institut St. Joseph, à La Louvière.

Ces écoles ont pour but d'instruire les brasseurs, les fils de brasseurs, les futurs directeurs de brasserie ou les aspirants-brasseurs ; elles leur apprennent à exercer leur profession dans les meilleures conditions pratiques et scientifiques. Les cours s'adressent aussi à une classe de travailleurs plus modestes, aux contremaîtres et aux ouvriers brasseurs.

L'enseignement est de deux années pour les premiers et d'une année pour les seconds ; il est à la fois théorique et pratique.

Les six écoles spéciales réunies comptent actuellement 66 professeurs, 555 élèves, et coûtent annuellement 233,343 francs.

Les écoles spéciales jouissent toutes d'une légitime prospérité et rendent d'utiles services tant en Belgique qu'à l'étranger.

En résumé l'enseignement technique en Belgique, avait en 1886 : 92 écoles, 507 professeurs et 12,014 élèves ; il comporte aujourd'hui : 375 institutions, 1,428 professeurs et 30,472 élèves ; tous les chiffres d'il y a dix ans, sont donc à peu près triplés.

Ces résultats sont encourageants pour notre petit pays ; ils montrent le chemin parcouru et le bien réalisé pour l'ouvrier, avec des ressources pécuniaires relativement faibles. Il reste encore, peut-être, beaucoup à faire, mais "succès oblige" et les services déjà rendus sont un sûr garant de ce qui sera fait à l'avenir. Ces progrès, qui n'ont pas été obtenus sans vaincre des difficultés, doivent être attribués aux efforts constants du Gouvernement, au puissant appui de Monsieur le Ministre Nyssens et au zèle dévoué de M. l'Inspecteur Général Rombaut.

Permettez-moi, Mesdames et Messieurs, avant de terminer, d'attirer votre attention sur la collectivité de l'enseignement technique, organisée à l'Exposition internationale, ouverte en ce moment à Bruxelles.

Le Ministère de l'Industrie et du Travail a réuni dans cette collectivité tout ce qui peut aider à faire connaître et à étendre la cause si intéressante de l'enseignement technique populaire. Nous nous mettrons volontiers à la disposition de tous ceux d'entre vous qui voudraient nous faire l'honneur de visiter cette partie de l'Exposition.

Je crois intéressant aussi de signaler que le Gouvernement a fait publier un rapport général sur la situation de notre enseignement technique depuis douze ans ; ce rapport, qui est sous presse, paraîtra incessamment.

Je me fais un devoir de soumettre à l'éminente assemblée, ici réunie, le voeu émis au moment de mon départ par Monsieur le Ministre

1.—ENSEIGNEMENT PROFESSIONNEL POUR JEUNES FILLES.

Tableau indiquant le nombre des institutions subsidiées, le nombre des maîtresses, le nombre des élèves, le nombre des diplômes délivrés et les subsides accordés en 1895—96.

DÉSIGNATION DES INSTITUTIONS.	ANNÉE 1885—86.				ANNÉE 1895—96.				SUBSIDES POUR 1895—96.				
	Nombre des institutions subsidiées.	Nombre des Directrices, Institutrices et Maîtresses.	Nombre des élèves fréquentant régulièrement les cours.	Nombre des diplômes délivrés.	Nombre des institutions subsidiées.	Nombre des Directrices, Institutrices et Maîtresses.	Nombre des élèves fréquentant régulièrement les cours.	Nombre des diplômes délivrés.	de l'Etat.	des Provinces.	des Communes.	Produits divers.	TOTAUX.
Ecoles professionnelles	3	65	866	54	14	157	2,022	133	Frs. 66,095	Frs. 10,800	Frs. 70,258	Frs, 101,040	Frs. 248,193
Cours professionnels	—	—	—	—	3	14	156	17	7,000	700	17,930	180	25,810
Ecoles professionnelles et ménagères	—	—	—	—	6	58	467	25	22,276	6,100	27,648	26,582	82,606
Ecoles ménagères et professionnelles	—	—	—	—	3	13	259	4	4,932	1,562	1,920	5,265	13,679
TOTAUX......	3	65	866	54	26	242	2,904	179	100,303	19,162	117,756	133,067	370,288

2.—ENSEIGNEMENT PROFESSIONNEL POUR GARÇONS.

Tableau indiquant le nombre des institutions subsidiées, le nombre des professeurs, le nombre des élèves, le nombre des diplômes délivrés et les subsides accordés en 1895—96.

DÉSIGNATION DES INSTITUTIONS.	ANNÉE 1885—86.				ANNÉE 1895—96.				SUBSIDES POUR 1895—96.				
	Nombre des institutions subsidiées.	Nombre des Directeurs et Professeurs.	Nombre des élèves.	Nombre des diplômes délivrés.	Nombre des institutions subsidiées.	Nombre des Directeurs et Professeurs.	Nombre des élèves.	Nombre des diplômes délivrés.	de l'Etat.	des Provinces.	des Communes.	Produits divers.	TOTAUX.
Ecoles professionnelles	2	3	87	18	12	63	833	61	Frs. 28,470	Frs. 9,600	Frs. 26,991	Frs. 26,932	Frs. 91,993
Ecoles St. Luc	2	8	240	—	4	39	1,544	—	20,120	1,500	—	37,199	58,819
Cours professionnels	1	1	30	5	2	3	55	—	692	100	802	—	1,594
Cours commerciaux, de langues et scientifiques	2	21	102	5	5	39	869	43	3,800	1,000	9,194	9,096	23,090
TOTAUX......	7	33	459	28	23	144	3,301	104	53,082	12,200	36,987	73,227	175,496

3.—Ecoles Industrielles.

Tableau indiquant le nombre des écoles, des professeurs, des élèves, des diplômes délivrés, ainsique la répartition des élèves au point de vue de l'inscription aux cours, de l'âge et de la profession.

	1885—86.	1895—96.
Total des Ecoles existantes	32	40
Nombre des Directeurs et Professeurs	329	466
Inscriptions aux Cours—		
1° de semaine	6,997	8,867
2° de semaine et de dimanche	2,613	4,567
3° de dimanche	1,435	3,206
Population des élèves inscrits	9,478	13,015
Nombre de jeunes filles comprises dans la population	18	108
Nombre de diplômes généraux et spéciaux délivrés	368	684
Classement des élèves par Catégorie—		
1° Ouvriers	6,263	8,555
2° Ecoliers	1,490	2,313
3° Employés	1,355	1,571
4° Sans profession	370	586
Classement des élèves d'après l'âge—		
1° Au dessous de 14 ans	936	1,334
2° de 14 à 16 ans	3,027	3,915
3° de 16 à 20 ans	3,338	5,069
4° au dessus de 20 ans	2,177	2,697

Subsides Accordés.

	1895—96.
	Frs.
1° Par l'Etat	250,581
2° Par les Provinces	124,302
3° Par les Communes	242,423
4° Produits divers	40,457
Total	657,763

Nyssens: "celui de voir réunir le plus tôt possible à Bruxelles le prochain Congrès de l'Enseignement technique."

Notre capitale conviendrait parfaitement pour l'organisation d'un Congrès de ce genre, et comme le disait Monsieur Saignat au dernier Congrès de Bordeaux: ces réunions, pour conserver toute leur utilité, doivent être internationales et se réunir alternativement dans des pays différents. (Les Congrès de l'Enseignement technique, antérieurs à celui réuni actuellement à Londres, ont été organisés en 1886 à Bordeaux, en 1889 à Paris et en 1895 à Bordeaux.)

J'ai l'honneur de soumettre l'idée de Monsieur le Ministre Nyssens aux Membres du Congrès et j'espère qu'elle obtiendra leur bienveillante approbation.

J'ai cru intéressant de résumer dans les tableaux statistiques qui suivent, la situation de l'enseignement technique, tel qu'il est organisé actuellement en Belgique.

4.—ÉCOLES SPÉCIALES.

Tableau indiquant le nombre des institutions subsidiées, le nombre des professeurs, le nombre des élèves, le nombre des diplômes délivrés et les subsides accordés en 1895—96.

DÉSIGNATION DES INSTITUTIONS.	ANNÉE 1885—86.				ANNÉE 1895—96.				SUBSIDES POUR 1895—96.				
	Nombre des institutions subsidiées.	Nombre des Directeurs et Professeurs.	Nombre des élèves.	Nombre des diplômes délivrés.	Nombre des institutions subsidiées.	Nombre des Directeurs et Professeurs.	Nombre des élèves.	Nombre des diplômes délivrés.	de l'Etat.	des Provinces.	des Communes.	Produits divers.	TOTAUX.
Institut supérieur de commerce d'Anvers	1	16	137	37	1	16	230	57	Frs. 43,275	Frs. —	Frs. 14,425	Frs. 51,396	Frs. 109,096
Ecole provinciale d'industrie et des mines du Hainaut, à Mons	1	13	58	15	1	17	215	30	21,136	34,512	10,209	13,000	78,857
Ecole supérieure des textiles, à Verviers.........	—	—	—	—	1	9	17	—	*	*	*	*	*
Ecole de brasserie, rue de Bruger, à Gand......	—	—	—	—	1	12	57	26	5,827	750	1,000	24,263	31,840
Ecole de brasserie, Institut St. Liévin, à Gand	—	—	—	—	1	6	19	6	2,500	—	—	4,750	7,250
Ecole de brasserie, Institut St. Joseph, à La Louvière	—	—	—	—	1	6	17	6	2,500	—	—	3,800	6,300
TOTAUX..................	2	29	195	52	6	66	555	125	75,238	35,262	25,634	97,209	233,343

* Subside compris dans celui de l'Ecole industrielle de Verviers.

5.—ENSEIGNEMENT INDUSTRIEL, PROFESSIONNEL ET MÉNAGER.

Tableau récapitulatif indiquant le nombre des institutions subsidiées, celui du personnel enseignant et des élèves, ainsique les subsides accordés en 1895—96.

DÉSIGNATION DES INSTITUTIONS.	ANNÉE 1885—86.			ANNÉE 1895—96.			SUBSIDES POUR 1895—96.				
	Nombre des institutions subsidiées.	Nombre des Directeurs, Professeurs et Institutrices	Nombre des élèves.	Nombre des institutions subsidiées.	Nombre des Directeurs, Professeurs et Institutrices	Nombre des élèves.	de l'Etat,	des Provinces.	des Communes.	Produits divers.	TOTAUX.
Enseignement professionnel pour jeunes filles		65	866	26	242	2,904	Frs. 100,303	Frs. 19,162	Frs. 117,756	Frs. 133,067	Frs. 370,288
Ateliers d'apprentissage pour jeunes filles et pour garçons ...	46	47	926	55	60	1,158	40,330	12,870	18,553	18,636	90,389
Enseignement professionnel pour garçons	7	33	459	23	144	3,301	53,082	12,200	36,987	73,227	175,496
Ecoles spéciales..	2	29	195	6	66	555	75,238	35,262	25,634	97,209	233,343
Enseignement industriel..	32	329	9,478	40	466	13,015	250,581	124,302	242,423	40,457	657,763
Enseignement ménager	2	4	90	225	450	9,539	92,136·50	26,074	59,008	73,648	250,866,50
TOTAUX.....................................	92	507	12,014	375	1,428	30,472	611,670·50	229,870	500,361	436,244	1,778,145,50

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

PRIZES FOR DESIGNS FOR FURNITURE.

The Council of the Society of Arts hold a sum of £400, the balance of the subscriptions to the Owen Jones Memorial Fund, presented to them by the Memorial Committee, on condition of their spending the interest thereof in prizes to "Students of the Schools of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones."

The prizes will be awarded on the results of the annual competition of the Science and Art Department. Competing designs must be marked "In competition for the Owen Jones Prizes."

No candidate who has gained one of the above prizes can again take part in the competition.

The next award will be made in 1898, when six prizes are offered for competition, each prize to consist of a bound copy of Owen Jones's "Principles of Design," and the Society's Bronze Medal.

Proceedings of the Society.

HOWARD LECTURES

THE MECHANICAL PRODUCTION OF COLD.

By Prof. J. A. Ewing, M.A., F.R.S., M.Inst.C.E.

Lecture V.—Delivered February 25, 1897.

Trials of Refrigerating Machines.

We have endeavoured to compare the various types of machine from the standpoint of thermodynamic theory, but the conditions in real work are too complex to allow any theory to agree more than approximately with the facts. For more exact knowledge of co-efficients of performance an appeal has to be made to experiment. Trials of refrigerating machines have been carried out, not in great numbers, but in several cases with all possible care, and have yielded data of much value. In the most complete trials three quantities are observed—the work done, the heat absorbed, and the heat rejected. The work done is most directly determined by taking indicator diagrams from the compressor cylinder, just as a steam cylinder is indicated, but with one or two differences in points of detail. For example, in the ammonia machine the indicator should be entirely composed of iron or steel on account of the chemical action of ammonia or brass, and further the connecting pipes which lead to the indicator cylinder itself should be considerably smaller than they usually are in steam-engine work, in order not to add unduly to the volumes of the clearance. The clearance is generally so small in a compressor that unless this precaution is attended to the very act of taking an indicating diagram will alter materially the form of the diagram. There is no serious difficulty in taking good indicator diagrams in ammonia machines, but carbonic acid compressors are more awkward on account both of the smallness of the clearance and the greatness of the pressure. When it is impracticable to indicate the compressor a good idea of the work done in it may be got by indicating the steam-cylinder and allowing for the frictional loss in the engine and compressor.

The second quantity to be measured in a systematic test is the heat which is given up in the condenser. For this purpose trials are best made with submerged condensers, not with the open-air evaporative condensers which are so largely used in ordinary work. With a submerged condenser, we measure the quantity of water flowing through it and the amount by which its temperature rises. Suppose, further, that the machine is applied to the cooling of brine or some other liquid. Then, in a precisely similar way we can measure the amount of heat which in taken up in the brine by causing it to circulate through the refrigerator and observing the quantity which circulates in a given time and the extent to which its temperature is lowered in passing through. To make the conditions steady in a trial the brine must in some way be warmed up again before it returns to the refrigerator. The range of this alternate cooling and heating of the brine need not be wide, so that the absorb-tion may take place nearly at one temperature. In the chief experiments which have been specially carried out to test the performance of such machines, the refrigerated brine has generally had its temperature raised by steam-heating—that is to say, it has been removed from the refrigerator into a vessel where it has been subjected to the action of a coil of steam-pipes sufficient to raise its temperature through a few degrees, and then it has been put back into the refrigerator, and so on, a continuous circulation being kept up.

If all these observations are carried out, we have the data for drawing up a thermal balance-sheet for the refrigerating machine. On one side is the amount of heat rejected, Q_1; on the other is the heat absorbed, Q_2, together with the thermal equivalent of the work done, W. If we had a perfectly accurate measurement of all the heat rejected, and, again, of all the heat absorbed, and all the work done, the two sides of the account should balance. You never find them balance, and why? Because, in the first place, heat is taken up from the surrounding atmosphere to an extent which we have no means of directly measuring. The brine tank and the pipe leading from the refrigerator to the compressor, and so on, are at a temperature below that of the atmosphere, and however well they are lagged with non-conducting material, we cannot avoid a leakage of heat in from the outside. Then, again, in addition to the work done in the compressor, as measured from the indicator diagram, there is a term which may be of considerable importance, especially in small machines—the work spent in overcoming the friction of the piston rings and the gland of the compressor cylinder. This work is given to the working substance as heat, and should form an item on that side of the account on which are summed the heat absorbed by the substance and the work spent upon it.

The discrepancy found in trials between the two sides of the account is of the kind these considerations would lead us to expect. The heat extracted from the brine, plus the heat equivalent of the indicated work in the compressor, is less than the heat rejected to the condenser by some 3 or 4 per cent. in the most careful experiments. Our experimental knowledge of the performance of refrigerating machines is mainly due to the enterprise of the Polytechnic Society of Munich. More than 10 years ago that society entrusted a Commission with the task of undertaking trials. The first report of the Commission was issued in 1887,* the second report in 1890, and there has since been a third briefer and less detailed report issued in 1893. The trials were conducted by Prof. Schröter, who has had an unrivalled experience in such work; they were carried out in the most scientific spirit, and the results command the fullest possible confidence. The report of 1887 deals with a large number of different types of refrigerating machines, which were tested while doing their ordinary commercial duty. Among them were ammonia absorption machines, a vacuum absorption machine using water and sulphuric acid, compression machines of various types, and a Bell-Coleman air-machine. Then in the 1890 report results are given from tests which were made under what one may call more scientific conditions. In the interval between those two reports the commission established, at the instigation of Prof. Linde, a testing station supplied with every requisite for carrying out trials in the most complete manner. It invited the various makers of refrigerating machines to send their machines for trial, and tests were made on two machines, namely, a Linde machine using ammonia, and a Pictet machine using sulphurous acid. The report of 1893 gives the results of further trials made with another Linde machine embodying all the most recent improvements. In Fig 33 the chief results of these trials of vapour compression machines are graphically set forth, namely, those in the report of 1890, where a Linde machine and a Pictet machine were tested; and those in the report of 1893, where an improved Linde machine was tested. The curves have been drawn to show the coefficient of performance when the brine had various temperatures. The brine was alternately refrigerated and re-heated by steam,

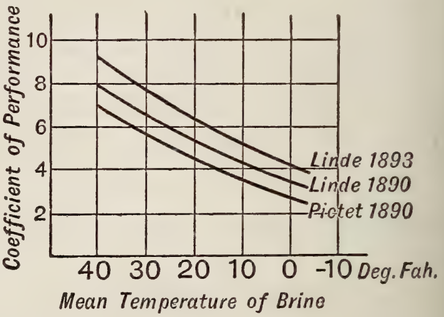

FIG. 33.

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* Untersuchungen an Kältemaschinen Verschiedener Systeme (Munich; R. Oldenbourg).

through 3° C., or approximately 5° Fahr., but its mean temperature is taken in drawing the curves. Observe that the ammonia machine was somewhat better than the sulphurous acid machine in the trials of 1890. This is what we should expect from the theoretical considerations already treated of. Further, in the trials of 1893, various small improvements brought about a still higher performance. The results then obtained represent what we may call the high water mark of refrigeration, so far, at least, as definite tests have been made. It is true that these experiments were made with a comparatively small machine, one taking only about 16 horse-power to drive it, and no doubt better results might be obtained with a larger machine, for in refrigerating machines, as in steam-engines, increased power and size give, within limits, increased efficiency by making the incidental losses due to friction and conduction form a smaller fraction of the whole effect. It is a remarkable fact that the performance is so good in a machine of so moderate a size.

The following Table gives a summary of the results got in Prof. Schröter's final trials of a "12-ton ice-making" Linde machine, driven by a single cylinder steam-engine, which was doing about 16 indicated horse-power. The condensing water was supplied at 10° C. and heated to 20° C. in going through the condenser. The figures relate to four trials, with various brine temperatures, the interval of temperature through which the brine was cooled being 3° C. in each case :—

	I.	II.	III.	IV.
Brine temperature....................	6° C. to 3° C.	– 2° C. to – 5° C.	– 10° C. to – 13° C.	– 18° C. to – 21° C.
Mean ,, ...	$4\frac{1}{2}$° C.	– $3\frac{1}{2}$° C.	– $11\frac{1}{2}$° C.	– $19\frac{1}{2}$° C.
,, ,, Fahr. (approx.).......	40° F.	26° F.	11° F.	– 3° F.
Indicated horse-power (compressor).....	14·5	14·5	13·7	12·1
,, ,, (steam cylinder)..	16·0	16·7	15·5	14·4
Co-efficient of performance (namely, cold produced, divided by indicated work in compressor)......................	9·36	7·21	4·98	3·9
Production of cold in British thermal units per lb. of feed supplied to the boiler..........................	1,100	785	565	436
Ratio of heat abstracted to heat supplied $\frac{Q_2}{Q}$	0·97	0·71	0·51	0·39

The heat account for one of the trials (the third) is subjoined, the quantities all being stated in British thermal units per lb. of feed supplied to the boiler.

	Thermal Units.		Thermal Units.
Units of heat rejected to cooling water in condenser	702	Units of heat extracted from brine	565
		Heat equivalent to indicated work in the compressor..	113
			678
		Balance unaccounted for (being 3·4°/o of the whole)......	24
	702		702

It will be seen that the effective indicated work in the compressor is from 85 to 90 per cent. of that of the steam cylinders—a large proportion. The last two lines in the Table make it possible to compare these performances with those of absorption machines, where heat is directly applied to produce cold. They give the amount of the refrigerating effect on the brine per lb. of steam supplied to the engine, and also the ratio $\frac{Q_2}{Q}$ of the refrigerating effect to the heat supplied in the steam.

We saw that Professor Denton, in his trials of an ammonia absorption machine, obtained a heat ratio $\frac{Q_2}{Q}$ of only 0·26, and this is the highest figure for such machines of which there is any record. Professor Schröter, in the earlier report ofthe Munich Commission, made some trials of absorption machines, but obtained somewhat less favourable results. Compare this result with the figures given here for a compression machine. Against the

0·26 of the absorption machine we have about 0·6 as the ratio of $\frac{Q_2}{Q}$ under like conditions as to temperature, for the conditions in the absorption machine trials come about midway between those of the second and third tests in the Table. It may be concluded, so far as we have definite data, that a good compression machine may extract from 2½ to 3 times as much heat as a good absorption machine, both being supplied with equal amounts of heat (in steam), and both working between the same limits of temperature.

Again, if we compare these figures with those relating to air machines of the Bell-Coleman or other types, we find the co-efficient of performance of the ammonia compression machine to be about six times as great as that of the air machine. I pointed out that Kirk's regenerative air machine had a co-efficient of nearly one, but that the co-efficient in the Bell-Coleman type was more generally 0·6 or 0·7. This is in cold storage uses, when the brine temperature (if brine were used) would be about 15° Fahr. The co-efficient in these Linde trials for this brine temperature is between five and six, or if we take the indicated work in the steam cylinder as the datum of comparison, it is about four or five. That, in round numbers, is about six times as good as anything obtained with an air machine under the actual conditions of cold storage.

It is further interesting to compare these figures with the calculated performance of ideal machines. Take as an example the second experiment. The ideal value of the co-efficient of performance of an ammonia refrigerating machine following that cycle, but without any losses other than those which are absolutely intrinsic in the cycle (due to the absence of an expansion cylinder) would be 10·2; the actual co-efficient is 7·2. In other words, the machine as actually tested has an efficiency which is fully 70 per cent. of the ideal efficiency of the process. By the ideal efficiency, I mean the efficiency of the compression cycle working between the same limits of temperature with adiabatic compression and without any incidental losses. It is a very remarkable fact that the real machine should be able to achieve 70 per cent. of the efficiency of an ideal machine. If we turn to the steam-engine, we find in general that the proportion between the real performance and the ideal performance is not so good as this, and if we turn to any other form of refrigerating machine, the absorption type or the air machine, we find that the real performance is a very much smaller fraction of the ideal. One may say that a strong point to the credit of the ordinary compression type of refrigerating machine is that it is able in practice to approximate nearly to its own ideal as well as having an ideal is not far short of the perfect Carnot ideal. If we compare the experimentally-found co-efficient of performance with the ideal of the Carnot cycle, we find that with the same limits of temperature the actual performance comes to over 68 per cent. of that perfect standard. There is, therefore, no very great margin for improvement in the performance of such a machine. The real performance must fall short of the ideal for reasons which have been already suggested. There is loss through conduction of heat from outside to cold parts of the machine. There are losses due to the friction in the cylinder, and there is the loss which proceeds from exchanges of heat between the working substance and the metallic surface with which it is brought in contact during compression. This is an action like that which steam engineers fully recognise now-a-days as occurring between the steam in an engine and the cylinder walls. The exchanges of heat there result in a diminished efficiency of performance, and in the same way the general effect of the exchanges in a refrigerating machine is to take something away from the performance as calculated from an adiabatic process.

In addition to these important results published by the Munich Commission, certain other data are available, which are in general accordance with them. Professor Denton has published in vol. 12 of the "Transactions of the American Society of Engineers" a test of a much larger ammonia compression machine, made by the Consolidated Ice Company, working with a process of dry compression, and, therefore, differing in this detail from the Linde process. He found a co-efficient of performance which comes between the Linde results of 1890 and those of 1893. This bears out the remark made in last lecture to the effect that from the theoretical side it does not much matter whether the process is conducted in the Linde manner with wet ammonia, which remains saturated during compression, or with dry ammonia, which becomes superheated. I said that the dry process was theoretically a little less efficient than the wet, and Professor Denton's tests, although made with a larger machine than either of the machines used in those tests, did in fact give a result somewhat inferior to the best tests obtained by the smaller Linde machine.

TESTS OF A SMALL AMMONIA MACHINE.

Through the kindness of Mr. Lightfoot, I have been able to make some tests in the Engineering Laboratory at Cambridge with a small ammonia compression machine of the Linde type. No results seem hitherto to have been published for a quite small ammonia compression machine. In this case the machine took only about 1½ horse-power; it is nearly the smallest machine made by the Linde Company. The trials were carried out in a manner very similar to Professor Schröter's, except in one particular where the procedure was novel. The brine, instead of being taken out of the refrigerating tank, heated, and put back again, was continuously heated while it was in the refrigerating tank by electric means. A number of cans in the brine tank, which usually serve for ice making, were partly filled with frames containing incandescent electric lamps. These cans were immersed in the brine, and were fastened down by the non-conducting cover of the tank. The lamps, when excited by the electric current, heated the brine, and the current was adjusted so that the heating by the electric lamps exactly balanced the cooling by the refrigerating machine. There was no practical difficulty in adjusting the electric current to keep the temperature of the brine steady, and when such a state of balance was arrived at then the amperes and volts of the current showed how much heat was being given to and taken from the brine. The method has the advantage of allowing a trial to be made in a very short space of time. A sensitive electric thermometer, consisting of a coil of wire whose resistance was continuously measured, was spread about through the brine tank, and served to show at once any small variation of temperature. The results show that in a small machine of this kind with a brine temperature of 23° Fahr. the co-efficient of performance was 3·2, whereas with the same brine temperature the co-efficient ranges from 5 to nearly 7 in the large machines. The difference is to be explained by the fact that this is so much smaller a machine. The compressor horse-power was only about 1½, and friction played a relatively large part. We can no more expect to realise a good approach to the ideal in a small refrigerating machine than we can expect a steam-engine of two or three horse-power to give figures representative of the efficiency of a large engine. For so small a machine it is an excellent performance to obtain, with brine at a temperature of 23°, an amount of cooling which is more than three times the amount of the work expended in driving the machine. The heat account in these trials shows a relatively large unaccounted-for balance, and that is what theory would lead us to expect.

TRIALS USING CARBONIC ACID.

Turning next to tests of the carbonic acid machines, we find a comparative paucity of data. There are not by any means the same number of figures available as to the performance of carbonic acid machines. Mr. Windhausen has been kind enough to send me particulars of early experiments made by him mainly to determine whether carbonic acid was capable of acting effectively with comparatively high temperatures of condensing water. The experiments gave satisfactory assurance as to this point. Mr. Hesketh, in his paper read before the British Association in 1895, gives the results of a number of tests made by Messrs. Riedinger, German manufacturers of the Windhausen type of carbonic acid machine. For the purpose of making a comparison between the heat extracted and the work expended in carbonic acid machines, data are to be found in an important paper by Dr. Linde, who has carried out a series of tests making a direct comparison between an ammonia machine and a carbonic acid machine when both were working under as nearly as possible the same conditions.* He found when the temperature in the condenser was 72° Fahr., and the temperature of the brine was the same in both cases, viz., about 15° Fahr., that the co-efficient of performance in the carbonic acid machine was 82 per cent. of the co-efficient of performance in the ammonia machine, and that when the temperature in the condenser was raised to 95° Fahr., so as to be above the critical temperature of carbonic acid, then the co-efficient of performance was just 50 per cent. of that of the ammonia machine working between the same limits of temperature. Now, the relative efficiency of the two, as given by these figures, agrees remarkabiy well with what theory would lead us to expect. Professor Linde further found that if he artifically cooled the condensed liquid before allowing it to pass through the regulating valve until its temperature was lowered to that of the refrigerator itself, then he got the same amount of refrigeration whether he used ammonia or carbonic acid. That, again, is exactly the conclusion to which theory points. The difference in efficiency in the two substances is essentially due to the different amounts of heat which the two liquids convey from the condenser to the refrigerator. If we prevent either substance from carrying any heat by cooling it down before it passes the regulating valve, there is no difference between the two in the efficiency of their working. Under the ordinary conditions of working, we do not and cannot prevent this conveyance of heat, and then there is a difference that is comparatively small so long as the condenser temperature is low, but becomes large, reaching something like 50 per cent., under tropical conditions of condenser temperature.

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* Zeitsdrift für die gesammte Kälte-Industrie, 28 Jan., 1895, or Zeitschrift des Vereins deutscher Ingenieure, 2 Feb., 1895.

OTHER WAYS OF STATING PERFORMANCE.

An alternative mode which might be followed in stating the efficiency of refrigerating machines is to give instead of the co-efficient of performance the number of the thermal units of refrigerating effects per horse-power hour. To get this figure in British units it is only necessary to multiply the co-efficient of performance by 2545. Frequently the performance of machines is expressed with reference to ice-making. If you take 1 lb. of ice as requiring about 200 thermal units for its production—that is to say, 142 thermal units for the actual process of freezing—and the extra 58 or so for the preliminary cooling of the water and for the cooling of the ice below the temperature of freezing, you will find that the best results which are stated here correspond to a production of about 15 lbs. of ice per lb. of coal used. From 15 lbs. to 20 lbs. of ice per lb. of coal is the largest return that can be looked for in view of the results of the Munich experiments.

I have been interested to hear from Mr. Lightfoot that in the Linde ice-making factory at Hull, they are actually able to obtain 15 tons of ice by the consumption of one ton of coal. This, it should be added, is under conditions that are more favourable to economy of power than hold in most cases. Generally it is required to produce clear, transparent ice, and the water has to be distilled, and also to be stirred during the freezing. This is not necessary at Hull, for the ice made there is in the form of opaque blocks used in preserving fish, and when it is necessary the output per ton of coal will not be so large.

USES OF MECHANICAL REFRIGERATION.

I pass now to speak briefly of the various uses to which mechanical refrigeration is put. Perhaps the best indication of the extent and variety of these uses may be given by quoting from a statement issued by the Linde Company regarding the use to which 2,600 of their machines have been put. Out of those 2,600 it appears that 1,406 are employed in breweries, 403 are employed in cooling land stores for meat and provisions, that 204 are employed in cooling ships for the purpose of the transport of meat and provisions, 220 are employed in ice-making, 73 in dairies in butter-making, 64 in chemical factories, 17 in sugar-refining, 15 in candle-making, and 198 for "various purposes." It appears on analysis that the "various purposes" include chocolate manufacture, glue-cooling, rubber-cooling, skating rinks, manufacture of dynamite and cordite, manufacture of gelatine plates for photography, the keeping cool of the eggs of the silkworm until the mulberry leaves are ripe, and also such special uses as that which is known as the Poetsch process of sinking shafts. This is a peculiar and interesting application of refrigeration which may be noticed in passing. When a shaft such as a coal mine shaft has to be sunk through water-bearing strata, particularly through quicksands, one of the most convenient ways of doing it is to refrigerate the circumference of the shaft, and thus keep out the water by maintaining a hard frozen shell round the portion which is being excavated. A similar process was successfully used in 1885, by Captain Lindmark, of the Swedish Royal Engineers, in the construction of a tunnel at Stockholm.

The use in brewing has been the sheet anchor of the mechanical refrigerating industry. It has employed probably more than half of all the refrigerating machines that have been built. In British breweries mechanical refrigeration is principally employed for cooling the wort through the medium of what is known as the Baudelot cooler; the wort is made to trickle over a series of pipes through which cold water is being circulated, this water having been previously cooled in a tank or by dripping over pipes. In exceptional cases the cooling of the wort is directly performed by letting it trickle over a stack of iron pipes in which ammonia is evaporated, instead of using cold water as an intermediate agent. On the continent of Europe, and in

America, where lager beer is brewed, and a lower temperature is needed in the various processes of brewing, fermenting, and so on, we find refrigeration applied to a greater number of purposes than is usual in English breweries. It is used not only in the Baudelot coolers for the wort, but also in the so-called "swimmers" in the fermenting vats, and also for keeping the beer cool in the cellars. In small breweries ammonia absorption machines are not uncommon, but where the work is to be done on a large scale the compression machine is preferred.

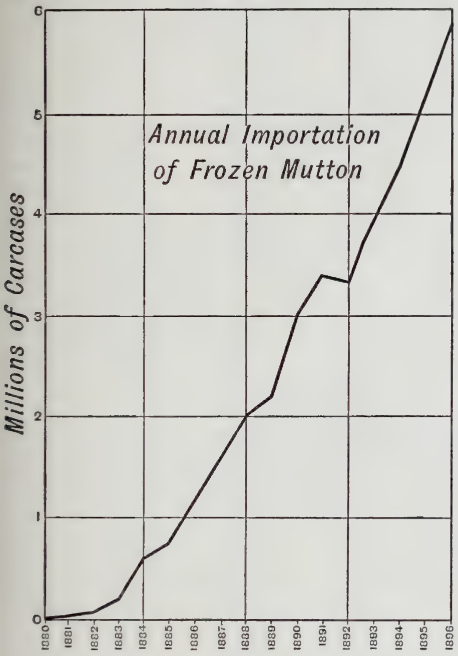

FIG. 34.

Next to brewing, the largest use to which refrigerating machines are put is the cooling of air for the purpose of storing and transporting meat and other provisions. The freezing of beef and mutton for cold storage is accomplished by cooling the atmosphere in which they are hung, and continued exposure to a cold atmosphere is all that is necessary to preserve them. When meat is cooled down to a temperature approximately equal to, or below the temperature at which water freezes, the ordinary processes of decay and decomposition are completely arrested. I understand bacteriologists to say that the septic germs may still be present and alive, but these are quiescent. They are hibernating as it were—not killed. Indeed, according to Prof. Dewar, you may expose germs to the vastly lower temperature of liquid air, and find them still alive when they are thawed. In any case it is certain that a moderate degree of cold serves to prevent or arrest the decomposition in meat, so that it may be kept in a cold atmosphere for any length of time without loss of freshness. Since 1879, when the first small experimental cargo of frozen meat was brought from the Antipodes the trade has grown to immense proportions From the annual report by Messrs. Weddell, it appears that during the year 1896 there were imported nearly 5,750,000 carcases of mutton, partly from Australia, partly from New Zealand, and partly from the River Plate. In the diagram, Fig. 34, Messrs. Weddell's figures have been graphically reproduced to show how the annual import of frozen mutton has developed from its beginning in 1880, when 400 carcases were brought into England, to 1896, when 5,750,000 carcases were brought. Besides this, there is the importation of frozen beef, which is not included in this diagram, and now amounts to something like 750,000 cwt. per annum; and further there is the importation from America of chilled beef, which is a separate branch of the trade. Beef and mutton brought through the tropics are frozen hard before shipment, and are kept frozen during the voyage. But this is not found to be necesssary when only the Atlantic is to be crossed. It is enough in that case to reduce the carcases to a temperature approximating to 32°, but not so low as to freeze the interior, and beef thus treated is said to be chilled, to distinguish it from the frozen beef which comes from Australasia or from the River Plate. The fleet of ships engaged in carrying frozen mutton number at the present time 123. Their holds are kept at a temperature of something like 20° Fahr. during the voyage, and have in the aggregate a

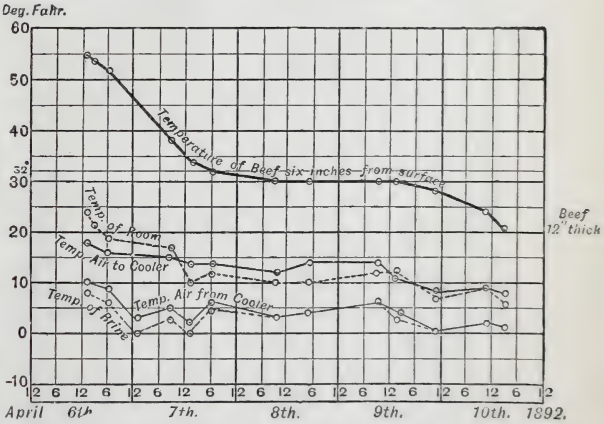

FIG. 35.—PROCESS OF FREEZING BEEF.

capacity of about 4,500,000 carcases. This is altogether apart from the amount of accommodation which is provided for the transport of chilled beef. Individual ships are fitted to take as many as 80,000 or 90,000 carcases in a voyage. The *Banffshire*, for instance, which was recently fitted up by the Linde Company, takes from 90,000 to 100,000 carcases. In order to prepare beef for a voyage of this sort the carcases are subjected to a temperature for several days of from 10° to 15° Fahr.

The diagram, Fig. 35 (p. 1085), shows observations taken by Mr. Lightfoot during the freezing of beef by subjecting it to a temperature which is indicated by the lowest of the curves, the temperature of the room in this case being approximately 10° Fahr. The temperature of the beef started at 55°, fell during the first 24 hours to 32°, then continued to fall slowly to 30°, and remained for more than 24 hours at that temperature, showing that the freezing was then going on. After that it continues to resume its fall, as the substance has then become completely frozen. It appears from this curve that the freezing point of beef is something like 30°, and that the freezing proper of a piece about 12 in. thick takes two or three days when the atmosphere in which it hangs is at about 10° Fahr.

COLD STORES.

The development of this trade has led to the creation of a large number of cold stores for the reception of the beef when it arrives, in addition to the freezing chambers through which it has to be put before it is shipped. In London alone there are 16 principal cold stores at the present time. One of the largest of these is the cold store at the Victoria Docks, which is made up of three separate box-shaped buildings of two storeys, covered by a roof with large projections, which cut off the walls effectually from the sun's rays. The rooms themselves are, as in all such stores, insulated by a considerable thickness of non-conducting material. Each of the three stores has its engine and refrigerating machine in the middle, and the plant is specially interesting as a survival of the application of the air process. The machines are of the Bell-Coleman type, by Messrs. Haslam; they take up approximately 200, 200 and 300 horse-power. It is safe to say that this type of refrigerating machine is one not likely to be introduced in the future into any large stores on land, not because it does not do its work thoroughly well, but it takes a needlessly large amount of power to do it.*

Fig 36 (page 1087) gives a sectional view of another great cold store, the largest single building of the kind in London. It is the store at Nelson's Wharf designed by Sir Frederick Bramwell and Mr. Harris, and refrigerated by a pair of machines of the De la Vergne ammonia compression type. One admirable feature about the design of this store is that it has no openings except at the top. The whole introduction and removal of the frozen carcases is performed through openings upon this top floor, where the cranes appear in the sketch. The store proper consists of the five storeys below this floor, three of these storeys being above the neighbouring ground level, and the other two under it. The cold rooms are in all 45 ft. deep, and about 150 ft. by 150 ft. in plan, and give a storage space of some 700,000 ft. They are thoroughly insulated by non-conducting material all round the sides, under the lowest floor, and over the ceiling floor. This arrangement has been adopted in recognition of the fact that the most convenient way of keeping a store cold is to make it a well of still air. The cold air is something like 1-12th heavier than an equal volume of atmospheric air, and, consequently, if there are any openings near the bottom air would tend to stream out just as a heavy liquid streams out of a hole made in the side of a cistern. In this case the cold air is kept in by the simple expedient of having no openings whatever, except the openings at the top. The frozen carcases are brought alongside in barges, and are raised to the top floor by ingenious mechanical ladders, in the form of endless chains, on the moving rungs of which the sheep are placed. From the top floor they are dropped down into the various chambers. In this store the refrigeration is performed by the direct expansion of ammonia without using brine. Each store is cooled by a network of ammonia pipes arranged along the ceiling.

At the time the machinery for this store was arranged, confidence in the system of direct refrigeration by ammonia was not so great as it is now, and a supplementary plant was placed in the engine-room, viz., a large cold air machine of the Bell-Coleman type by Messrs. Haslam. The air ducts connected with that machine appear in the drawing at the bottom of the building. I understand that

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* The cold stores at the Victoria Docks, as well as several other cold stores in London, are described in a paper by Mr. H. F. Donaldson, published by the Institution of Civil Engineers, Feb. 9, 1897.

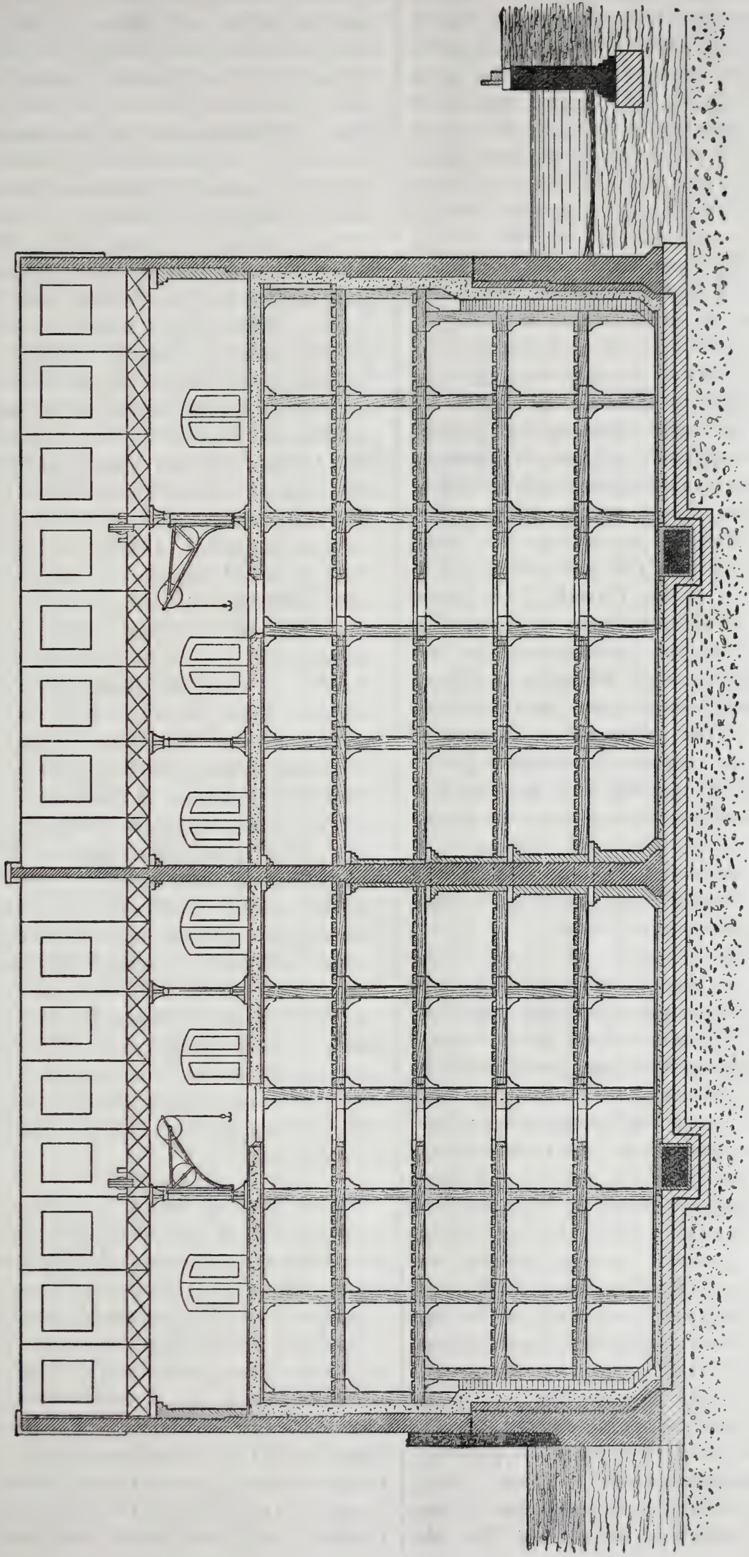

FIG. 36.—COLD STORE AT NELSON'S WHARF.

the cold air machine is not now used. It has been found that there is no need to maintain a circulation through these chambers; that the still cold air produced by the ammonia pipes answers the purpose well in this particular case. Here nothing is brought in except carcases, which have already been frozen hard. The conditions, therefore, are very different from those which hold in a store where provisions are placed in a soft state. Where that is the case there is an advantage in having the air in circulation, especially when provisions are liable to enter in a state of incipient decay. In such cases a movement of the air is good, but it is easily accomplished without resorting to an air machine for refrigeration. As to the advantage in point of efficiency of an ammonia machine, the contrast is sufficiently obvious when you consider that in the Victoria Dock Stores, and in these stores of Nelson's, there is practically the same capacity for carcases. The size of the two is almost identical. In the Victoria Dock Stores there are three air machines, requiring an aggregate of about 700 horse-power. In this store, as I saw it, a single ammonia machine, working at 30 or 35 horse-power, was performing the whole of the refrigeration. It should be added that part of this difference is due to the design of the stores, and part to the economy which comes of using ammonia as the working substance. Now, this economy in power may be retained along with the condition of circulation of air, and in a great number of cold stores this is actually done.

Among plans followed by the Linde Company, the device has been used of causing the ammonia to expand in a coil contained in a brine tank, in which there are revolving drums, the surfaces of which project into the air above. Over these a current of air is maintained by a fan; air, namely which comes out of the store, and goes back to it again after being cooled by passing over the drums. In other examples, instead of drums, a large number of revolving circular discs are arranged side by side parallel to one another on an axis, dipping into the brine tank, and bringing up their cold wet surfaces for the air to blow over. In the most recent examples, Mr. Lightfoot designs a still simpler arrangement. There is a stack of pipes in which the ammonia is being expanded. Over that stack a drip of brine is playing, and between the rows of pipes there are plates, so that the chilled brine which splashes off the pipes wets the surface of the plates. The air is blown through a chamber containing this stack of pipes and plates. It is, therefore, brought into intimate contact, not only with the wet surface of the pipes on which the brine is playing, but also with the wet surface of the plates, and thus meets a large surface operating to chill it. All these arrangements have an indirect advantage in this respect, that not only do they bring the air into very intimate contact indeed with the cold material, and lower the temperature nearly to the lowest point reached by the ammonia, but, further, that they clean the air. When the air comes in contact with cold wet surfaces it deposits moisture, because the wet surfaces are cooler than the air itself, and it also tends to deposit any germs or other impurities which may be suspended in it. The brine is found to exert a purifying effect on the air, which goes back to the chamber to a certain extent filtered, deodorised, and disinfected.

The arrangement I have just described is used on board ship as well as on land. On board ship the considerations governing the selection of refrigerating plant are, of course, different in several ways from those that apply on land. There the ammonia machine, the carbonic acid machine, and the cold air machine all, to a certain extent, maintain their position as rivals. No one of them can fairly claim to have displaced the others. Each has distinct merits from the point of view of the superintending engineer of a line of steam ships. The advantage of dispensing with the use of what he would probably call chemicals may lead him to prefer the air machine in cases where economy of coal is a secondary consideration. If he wishes to secure the greatest economy of coal he will prefer ammonia; if, on the other hand, he is afraid of the possible escape into the engine-room of a substance which would be, at all events, disagreeable and embarrassing if it escaped there, his choice may fall on carbonic acid.

DEFROSTING.

The quality of frozen beef, from the consumer's point of view, depends a good deal on how it has been thawed. At Nelson's Wharf an ingenious arrangement has recently been introduced for the purpose of what is technically called "defrosting" the beef. The beef to be thawed is hung in a special chamber, where a circulation or air is maintained over cold pipes, on which a deposit of moisture takes place, and then over warm pipes, by which the temperature of the air is raised before it again comes into contact with the beef. In this way the beef is subjected to an atmosphere which is warm enough to produce the desired thawing, and yet, at the same time, is dry, and is maintained dry, notwithstanding the amount of moisture it takes up from the beef itself. The object is to keep the dew point of the atmosphere lower than the temperature of the surface of the beef, and consequently to prevent moisture from being deposited upon the surface. In the ordinary thawing of beef by simply hanging it in a natural warm atmosphere, a deposit of moisture takes place which deteriorates the quality. This is prevented by regulating the temperature of the air in relation to its dryness. In Nelson's defrosting process it is kept dry by being made to give up its moisture to the cold pipes, before it is warmed by the hot pipes to the temperature proper for thawing.

Mechanical refrigeration is applied to a limited, but increasing, extent in the importation of frozen fish. Trawlers are in some cases supplied with refrigerating plant, and the fish when they are caught are plunged alive into cold brine, which freezes them solid. More commonly trawlers are supplied with ice for the preservation of their catch. Refrigerated fruit is imported from Tasmania and Jamaica, not at a temperature sufficient to freeze it, but at 50° or 55°, which is found to be low enough to prevent decay, and without unduly drying the fruit or injuring its flavour. As a *tour-de-force* flowers have even been brought from the Antipodes, enclosed with blocks of ice, and retaining, apparently, their original bloom.

ICE-MAKING.

In the application of mechanical refrigeration to ice-making, two general methods are employed, the can system, and the cell system. In both cases brine forms, as a rule, the medium by which heat is carried from the water to be frozen to the refrigerating agent. The broad distinction in the two methods is, that in the can system the water is enclosed in a number of cans or moulds which are immersed in an open brine tank, whereas in the cell system the brine is enclosed in a number of hollow walls, and between these are open spaces filled with the water to be frozen. In both cases, in order to produce clear ice, the water has to be agitated during the freezing. Under ordinary conditions water contains a considerable quantity of air dissolved in it; and as the temperature is lowered, and the water is frozen, the air is given out. If the water is at rest, and especially if the freezing goes on rapidly, the bubbles of air get caught and frozen into the mass, with the result that the ice is opaque. This may be prevented partly by having the water distilled in the first instance to get rid of all foreign matter, including air; and even if the water is not distilled, the opacity can, to a great extent, be avoided by keeping the water in movement while it freezes. To get the clearest possible ice, both precautions are sometimes taken; the water is both distilled and agitated.

One of the most approved methods of keeping the water in ice cans moving is illustrated in Fig. 37. The action here is pneumatic; the reciprocating motion of the air-pump piston causes a portion of the water in each can to be alternately sucked up into a small reservoir on the branch pipe dipping into the can, and returned to the can. In other cases mechanical stirrers are used, which are lifted out when the freezing of the block approaches completion. The ice-crystals grow from the sides of the mould inwards, and the direction of their growth is marked by the form taken by the imprisoned air-bubbles, which are found to some extent even in comparatively clear ice. The bubbles are drawn out into long, fine tubes, pointing inwards from the four sides and from the bottom of the mould and meeting in surfaces which are planes of weakness. The centre towards the top of the block is comparatively spongy, owing to imperfect agitation, and to the collection there of any impurities which the water may contain. To get the frozen ice out the moulds are lifted bodily, dipped into tepid water to thaw the surface, and tilted, so that the blocks slide out.

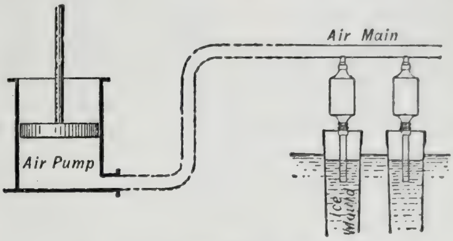

FIG. 37.—PNEUMATIC AGITATOR.

Fig. 38 illustrates the cell system of ice-making. The tank containing the water to be frozen has a double bottom, and also an enclosure at one side, in which a plunger moves slowly up and down, forcing the water backwards and forwards through apertures in the upper bottom, into the spaces between the brine cells. The brine cells are long, narrow cases of wrought iron, with a series of horizontal wooden partitions extending horizontally across each, arranged so that the cold brine circulates in a zig-zag, and comes in contact with every part of the surface of the cell. In the example shown here the brine cells have hollow projecting pieces on both sides, not only at the extremities, but also at the intermediate points, with the effect that the water space between one cell and the next is divided into three sections, completely enclosed within active brine walls. When the freezing is complete, and each section contains a solid block of ice, the circulation of cold brine is stopped, and tepid brine is passed into the cells to thaw off the blocks, which are then lifted out. In some applications of the cell system the hollow transverse projections from the cells are omitted, and the length of the water space is divided up by moveable plates of metal, which serve to conduct heat away from the ends of the blocks. The blocks are usually about 12 in. thick, 2½ ft. or 3 ft. long, and 4 ft. high, and the freezing takes about 3 days.

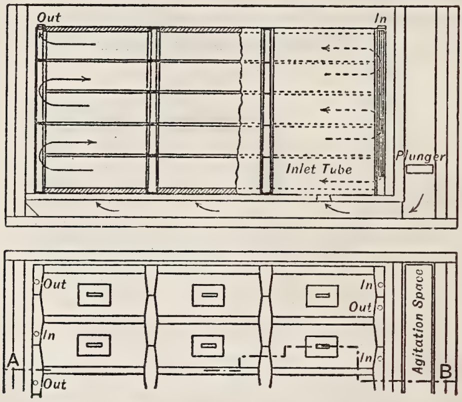

Fig. 38.—Cell System of Ice-making.

In an earlier variety of cell system the brine cells were flat plates placed somewhat further apart, and ice was formed in slabs, which were not allowed to become thick enough to meet in the middle. Slab-ice admits of being particularly clear, but it has the drawbacks of taking a long time to make, since the heat is taken from one side only, and of being rather shapeless. The slab process has, however, been brought to great perfection in America, where it is used, for example, by Messrs. Westinghorne and Kerr in the manufacture of what is there known as diamond-ice. The freezing surfaces in their plant are called dry-plates, and each consists of a gridiron of pipes in which ammonia is directly expanded. In some instances, the slab of ice is got off the dry-plate by passing warm ammonia gas through the pipes. In other cases, the slab is cut off by passing a steam cutter or knife with a thin hollow blade, served with live steam, between the dry-plate and the slab. The steam cutter also has transverse blades, which divide the slab into blocks of convenient size.

The preference which consumers generally feel for clear ice is mainly, if not wholly, sentimental. Opaque ice, or, as the Americans inauspiciously call it, from its resemblance to white marble, "tombstone-ice," is perfectly wholesome, provided, of course, the water used in making it is pure; on the other hand, the clearness of ice is no guarantee of the purity of the water. Opaque ice is cheap to make, and there seems no good reason why it should not be as acceptable as clear ice. Mr. Lightfoot informs me that in the Linde factory at Hull, where 15 tons of opaque ice are made for each ton of coal burnt, the whole cost of the manufacture is a trifle under 2s. per ton, this figure including the cost of coal, the labour in stoking and attending the machinery, the wages of crane-men, the engine-house stores, such as oil and waste, and the loss of ammonia, as well as the cost of water. He uses an ordinary two-cylinder compound engine employing steam at 110 lbs. pressure. At Grimsby, where the Linde Company has put up another larger ice plant on the same general lines, he expects to get even better results, as he will there use triple expansion engines with steam at 160 lbs.

An interesting application to be mentioned as we leave the subject is the formation of ice rinks. The Linde Company put up an ice rink at Frankfurt as early as 1891, in which the brine pipe system was used, the pipes being placed in a shallow tray or cell of water, which was frozen bodily. Of the two public rinks in London, the one at "Niagara" has De la Vergne ammonia expansion plant, and the floor is made by a horizontal gridiron of brine pipes immersed in a tray containing water, the whole of which becomes frozen. At the National Skating Palace, Messrs. Hall have a carbonic acid plant, with a floor made up of horizontal boxes or cells, through which brine is passed. The upper surfaces of these cells form a water-tight floor on which a comparatively shallow layer of water is frozen. The same advantage which this system posseses in having only a small volume of water to freeze, and in having a flat base below the water, is secured in another way in a rink which the Linde Company have put up at Nuremberg. There the floor is a shallow open tray, in which the water is frozen, resting on timbers which stand on a concrete floor below, and form channels through which a circulation of cold brine is maintained.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS, 1898.

The dates fixed for the Society's Examinations in 1898 are Monday, March 21st, Tuesday, 22nd, Wednesday, 23rd, and Thursday, 24th.

The Programme of Examinations is now ready, Copies of the Programme, with full details, and an Appendix containing last year's questions and reports by the Examiners, can be had, price 3d., post free, on application to the Secretary, Sir Henry Trueman Wood, Society of Arts, Adelphi, London, W.C.

Proceedings of the Society.

HOWARD LECTURES.

THE MECHANICAL PRODUCTION OF COLD.

By Prof. J. A. Ewing, M.A., F.R.S., M.Inst.C.E.

Lecture VI.—Delivered March 1, 1897.

The Production of Very Low Temperatures.

In none of the industrial uses already referred to is more than a moderate amount of refrigeration required. The temperature is rarely lower, and never many degrees lower than the zero of the Fahrenheit scale. It is, however, the case that in some processes considerably lower temperatures are employed. Substances used in medicine are purified by crystallising them out under extreme cold. The rectification of chloroform for instance, and of nitrous oxide, is carried out by the use of low temperatures, and, to give a recent example, acetylene is purified by subjecting it to a low temperature, and treating it with sulphuric acid. The acid is found not to act on the acetylene itself, when cooled to – 50° C., but to retain its action on the impurities which have to be removed. An easy means of getting low temperature (down to values approaching – 80° C.) when small quantities of material have to be dealt with, is furnished by flasks of compressed carbonic acid, which reaches that limit when allowed to evaporate in the air. Apart from commercial uses the production of very low temperatures is a problem of great physical importance, interesting alike in itself and in its results. In the last year or two great strides have been made in this subject. It is now an easy matter to produce the extreme degrees of cold necessary to liquefy oxygen and air, and it is not unlikely that the liquefaction of air will soon take its place among ordinary industrial operations. In order to liquefy any gas, the temperature must be reduced below its critical point, otherwise no amount of pressure, however great, will make the gas change its state. We might define the critical point of a gas as the highest temperature at which it exists in the liquid form under any pressure whatsoever.

Liquefaction of Gases by Cailletet and Pictet.

The attention of the scientific world was arrested in the closing days of the year 1877, or rather the beginning of 1878, by the news which reached it almost simultaneously from two sources, that two independent experimentalists had succeeded in liquefying certain of the so-called permanent gases which had been left unliquefied by the earlier experiments of Faraday. Cailletet and Pictet, within a few days of one another, but independently, and by more or less distinct methods, succeeded in liquefying oxygen, nitrogen, and other gases. Pictet employed what we may distinguish as the cascade or successive cycle method. The general idea of this method is illustrated in Fig. 39. Imagine a refrigerating agent, such as carbonic acid, to have been compressed and to expand through a valve into the chamber, A, where it evaporates. In the example as sketched it is evaporating into the atmosphere. When carbonic acid evaporates freely to the atmosphere it falls to a temperature of about –80° C. It could be made to go 30 degrees or more lower by using an air-pump to preserve a partial vacuum in the chamber; but, assuming the pressure in A to be atmospheric, the temperature then will be about – 80° C. Now we may use this as the condensing temperature of some other more volatile material. The material which is indicated in the sketch is ethylene, which was not used by Pictet, but has come into use subsequently, and has done good service in the hands especially of Professor Dewar. It forms a convenient intermediate link between the comparatively easily liquefiable carbonic acid and the much more difficult oxygen. Ethylene has a critical temperature of −10° C and needs only moderate pressure to liquefy it when exposed to a temperature of −80° C. It is pumped at the necessary pressure into the inner vessel at A, and is there liquefied and passes through an expansion valve to the outer vessel at B, where it evaporates. The pressure in B is supposed to be kept at something not much over one inch of mercury, and in that case the temperature reached by the ethylene in evaporating will be −130° C. After expansion it is re-compressed, so that the part of the apparatus in which the ethylene is carried through its cycle may simply be regarded as a separate vapour compression refrigerating machine, the same as the ordinary machine using ammonia or carbonic acid; B is the refrigerator and A is the condenser.

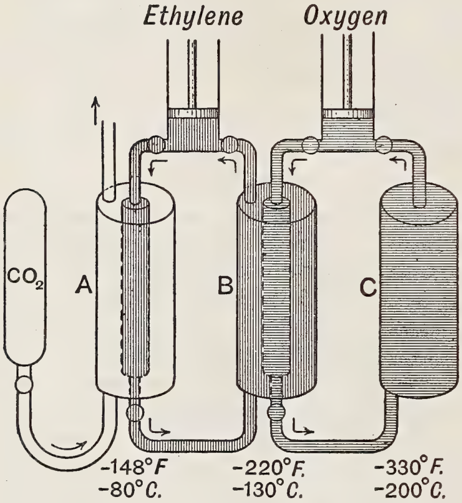

FIG. 39.—CASCADE METHOD OF REACHING VERY LOW TEMPERATURE.

The remainder of the apparatus is another similar machine, using, in this case, oxygen as its working substance, and with B as its condenser. The critical temperature of oxygen is about −150° C., and as the temperature in B is lower than that, the oxygen liquefies when compressed into the inner vessel at B. A moderate pressure of 20 or 30 atmospheres suffices. The liquid oxygen may be passed through a valve, and evaporated again in the vessel C, and in that way a temperature of −200° C., or lower, can be reached, the temperature, of course, in this last vessel depending on the pressure in it, and, consequently, on the rapidity with which the pump is worked. By working the pump tolerably fast, to preserve a good vacuum in C, we can get down to something like −220°, or even −225° C., a temperature which is no very long way above the absolute zero −273° C. In Pictet's cascade of successive cycles, the substances used were sulphurous acid and carbonic acid. The ethylene is a useful addition, as giving readily a temperature considerably below the critical point of oxygen. Without it, however, Pictet succeeded in liquefying oxygen by the device of letting it suddenly escape when under high pressure and after being cooled as far as the carbonic acid would cool it.

Cailletet's method was essentially different. He compressed the gas under very high pressure, and cooled it moderately, so that it was still far above its critical temperature. He then allowed it suddenly to expand by opening a tap, which relieved the pressure on the gas. It expanded, doing work against a column of mercury which was used in his apparatus, as the equivalent of a piston for compressing the gas. The gas, therefore, cooled itself, the expansion being sudden and nearly adiabatic. This reduced the temperature below the critical point, while the pressure was still left high enough to liquefy the gas at the temperature which it had then acquired. The chamber containing the gas was of glass, and the liquefaction was apparent in the forming of a mist.

Fig. 40, which is copied from a paper by Professor Dewar,* shows an improved apparatus based partly on Pictet's method, and partly Cailletet's. An iron flask, C, contains highly compressed oxygen or air, or whatever gas is to be treated. The gas passes from this flask, through a small pipe, I, into the tube, F. This tube is surrounded by a vessel containing some other material, G, more easily liquefied than the gas in the inner tube. Suppose, for example, that G contains carbonic acid. An orifice, E, near the top leads, by an annular passage round it, into an outer chamber, from which the gas is drawn away by an air pump. This keeps the temperature in G considerably below −80° C., and if a good vacuum is maintained it may be as low as −115° C. Say that compressed oxygen is coming into the tube F, the critical point of oxygen is only −115° C., and therefore, under these conditions, the oxygen will just fail to liquefy. But if the stopcock, A, is closed, the other, B, is suddenly opened to allow the pressure in F to be reduced; immediately a portion of the oxygen will condense. The adiabatic expansion which occurs in the sudden release of part of the gas causes what is left to fall to a temperature below its critical point. Instead of using carbonic acid in the jacket, G, Professor Dewar preferred to use liquid ethylene. Ethylene readily evaporates at a temperature below the critical point of oxygen, consequently, without using the sudden expansion which was the characteristic feature of Cailletet's method, the oxygen can then be condensed under steady pressure in the inner tube.

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* "Phil. Mag," Sept., 1894.

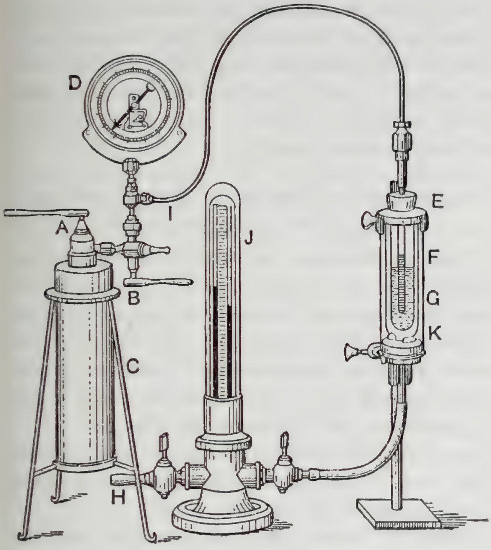

FIG. 40.

Two years later Professor Dewar decanted liquid oxygen into an open glass vessel from a spiral worm of copper tube, in which it was liquefied under pressure, the worm being cooled by enclosing it in a chamber from which liquid ethylene was evaporated. A tap at the bottom of the worm could be closed to allow the liquid oxygen to accumulate, and opened to let it pass into an open test-tube, which was kept cool by a jacket of evaporating ethylene in order to prevent the liquid oxygen from evaporating too rapidly. The ethylene was liquefied by compressing it in another worm surrounded by carbonic acid snow. His apparatus is shown in Fig. 41.* An interesting feature in this, as well as in the apparatus of Fig. 40, is that the liquid ethylene is, to a great extent, protected from conduction of heat into it by a jacket through which the vapour circulates which is given off by the ethylene itself. A similar arrangement for the decanting of condensed oxygen was used in 1890 by Professor Olszewski†, who has been assiduous in the same field of research. Other names which should be mentioned in this connection are those of the late Professor Wroblewski, Professor Witkowski, and Professor Onnes, of Leyden.

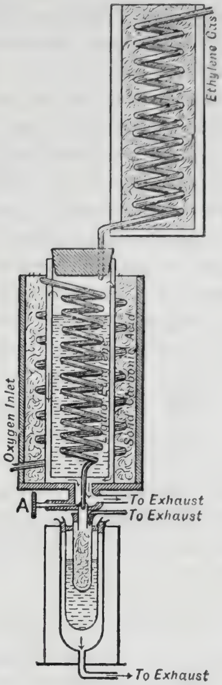

FIG. 41.

It would be beyond the scope of these lectures to refer to the large amount of work which has been done in investigating the properties of matter at extremely low temperatures or to make any attempt at apportioning credit to the various workers, whose claims have in some cases been discussed with a degree of warmth scarcely appropriate to the subject.

Nitrogen has been liquefied and solidified by the cooling caused by its own evaporation under a low pressure. Its freezing point is −214° C. Oxygen remains liquid when evaporating under a low pressure and can be used in this way as a refrigerating agent to produce temperatures as low as —225° C.; when cooling quietly at the pressure of the air its temperature is –183° C. Professor Dewar has solidified air, not as a homogeneous solid, but rather as a jelly in which the liquid oxygen is imprisoned in a sponge of solid nitrogen. Hydrogen has been liquefied, though with much greater difficulty than the other gases on account of the lowness of its critical temperature, which Wroblewski has determined to be –240° C. It was first liquefied by him in 1884 by aid of Cailletet's device of sudden expansion, the gas being already cooled under a pressure of 100 atmospheres to the temperature of boiling oxygen. More recently Professor Dewar has succeeded, by means to be presently mentioned, in geting a jet of liquid hydrogen which, though it evaporates too fast to be collected, has been used to freeze oxygen into a hard white solid.* The only widely-distributed element not yet liquefied is fluorine. [Fluorine, the last of the elements to yield, has now been liquefied by Moissan and Dewar,* who used liquid oxygen as the refrigerating medium, and found that fluorine would condense at –185° under atmospheric pressure into a clear yellow liquid which did not act chemically upon glass (July, 1897).]

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* See "Proc. Roy. Inst.," June, 1886, and "Phil. Mag.," March, 1895.

† "Phil. Mag.," Feb. 1895.

DEWAR'S VACUUM VESSEL.

The handling and keeping (for a time) of oxygen, air, and other gases in the liquid state has been immensely facilitated by the device of the vacuum vessel introduced by Dewar in 1891. The vacuum vessel has two glass walls with a sealed space between, from which the air has been very perfectly exhausted. Such a space acts as the very best possible insulator in regard to the conduction of heat. Heat will still pass across it by radiation, but the amount entering in that way is small compared with what would pass by conduction and convection if the vacuum space were full of air. When liquid oxygen or liquid air is poured into the vacuum vessel, the top of which is, of course, kept open, there is at first some quick ebullition, due to heat taken from the substance of the glass. But that is soon over, and the liquid then remains quiet, maintaining its low temperature by slow evaporation from the surface. It is the vacuum jacket which makes this quietness possible: without it the liquid gas would continue to boil away fast, through conduction of heat from outside. In some cases Professor Dewar reduces conduction even further by adding to the vacuum jacket a film of mercury spread over the surface of the glass, on the inner surface of the outer wall. The bright mirror surface thus produced reduces the absorption of heat by the outer wall, and allows much less radiation to get through. Professor Dewar finds that the rate at which heat leaks in through an ordinary vacuum glass, without the mercury film, is about one-sixth of the rate of heating when the vacuum is spoilt by letting in air, and, further, that when a mercury film is added the ratio is reduced to one-thirtieth.

REGENERATIVE METHOD OF PRODUCING VERY LOW TEMPERATURES.

The production of very low temperatures has recently received a novel and highly interesting development through an application of the regenerative principle. In speaking of machines which produce refrigeration by the expansion of air, I drew attention to the early suggestion by Siemens of the use of a regenerator or heat interchanger, and we saw that the regenerative principle again found application in the hands of Kirk.

Siemens, in his patent of 1857, describes the employment of an interchanger to extract cold from the air already cooled by the refrigerating machine, and thereby to cool the air which is on its way to being expanded. He pointed out that in theory at least there was no limit to the degree of cold which could be produced by the application of this interchanger. His provisional specification, which was never completed, gives an example of the temperatures that might be expected in a particular case, and proceeds:—"These temperatures are mentioned, not as absolute temperatures, but to show that the principle of the invention is adapted to produce an accumulated effect, or an indefinite reduction of temperature."

Siemens' idea was that the compressed air should pass through this interchanger, and should then be caused to do work in an expansion cylinder. This expansion would chill it, and it would then pass again through the interchanger, giving up its cold through the interchanger to the next succeeding supply of compressed air. The effect would be to make each fresh supply, on its way to the expansion cylinder, a little colder than the last. The cumulative fall in temperature resulting from this would only be limited by accidental losses due to conduction of heat from outside and to heat developed from friction within the machine.

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* "Proc. Roy. Inst.," March, 1896.

+ "Comptes Rendus," May 31, 1897; *Nature*, June 10, 1897.

It does not appear that Siemens followed up his idea. In 1885, Solvay patented an apparatus and process for producing, applying, and keeping up extreme temperatures. It was a regenerative method somewhat resembling that of Siemens, but with a regenerator instead of an interchanger. Solvay constructed an apparatus, by which he was able to reach a temperature of about –95° C.* He found that at that temperature the losses of cold balanced the gains. In 1892, Windhausen also patented an apparatus for producing extreme degrees of cold in which an interchanger essentially like that of Siemens was used in combination with an expansion cylinder.

Mr. Windhausen tells me that this invention is now in use on a commercial scale for such processes as the extraction of benzol from the mixed gases which are given off by the distillation of coal. The industrial application which he had in his mind was the separation of such volatile constituents of mixed gases, by fractional distillation at low temperatures. He tells me that about 50,000 cubic metres of the mixed gases given off from coal are treated daily under a pressure of 2 to 2½ atmospheres, the temperature reached is about –90° C., or –95° C. (the same temperature as Solvay reached), and at this temperature 20 to 30 grammes of benzol are got from each cubic metre of the gas, the remainder, namely about 98 per cent. passing off as gas to be used in the ordinary way.

The essential features in any such an apparatus are (1) the interchanger in which the compressed gas is made to give up its heat to the expanded gas, and (2) what may be called an appliance for producing a drop or step-down in temperature. In the inventions of Siemens, Solvay, and Windhausen, this step-down is produced by causing the gas to do work in an expansion cylinder. To make the interchanger of any use the gas passing out through it must have suffered a step-down from the temperature it took in coming in. The step-down is essential to a cumulative cooling, but it may be caused to happen in more than one way. There are, in fact, two ways by which that step-down in temperature may be produced. One is the way these inventors have used, namely, to make the gas do work against a piston in an expansion cylinder. But there is another way without the use of an expansion cylinder at all, namely, by merely letting the gas stream through a constricted aperture or throttle-valve. The gas then expands without doing work; it consequently becomes less cooled than when work it does in an expansion cylinder, but it becomes cooled to a certain small extent. In early experiments by Joule, where a gas moderately compressed and brought to atmospheric temperatures was allowed to expand through a throttle-valve from one vessel to another, he did not observe cooling, and he drew the conclusion that the internal energy of a gas does not depend upon its pressure, but only on its temperature, which is given in text-books as Joule's law. But later experiments by Joule himself in conjunction with Lord Kelvin, showed that this law was not exactly true of real gases, though it is convenient to retain it as an expression of what would be true of an imaginary "perfect gas." All real gases are more or less imperfect, in the sense that their physical behaviour deviates, more or less, from the simple laws which hold for a perfect gas. By forcing air and other gases through porous plugs (serving as constricted apertures) Kelvin and Joule established the fact that there is some cooling when they expand without doing work. The amount of the cooling is, in general, very small, and that is why an ordinary air refrigerating machine must have an expansion cylinder as well as a compressor cylinder. It would not produce any refrigeration worth speaking of if a regulating throttle-valve such as serves in an ammonia-machine were substituted for the expansion cylinder. In a vapour compression machine the regulating valve does serve as an effective substitute for the expansion cylinder because condensed vapour cools itself very much in passing through such a valve. Even in a carbonic acid machine in the tropics, where the compressed vapour is at a temperature above its critical point and is therefore not condensed, expansion through the regulating valve is still effective in cooling the gas, because the gas in this condition is very far from being a perfect gas and does not even approximately conform to Joule's law. But, with air, or with any of the so-called permanent gases, the deviation from Joule's law is small and the extent to which the temperature drops when compressed air streams through a throttle-valve is only about one quarter of a degree on the Centigrade scale for each atmosphere by which the pressure falls. This is when the air is at anything like ordinary atmospheric temperature; but if it is very cold to begin with, the drop in temperature is greater, for it is then a less perfect gas and deviates more widely from Joule's law.

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* "Comptes Rendus," Dec., 1895.

Suppose now that air or oxygen at a pressure say of 100 atmospheres is made to pass through a long coil of pipe and to escape at the end through a small nozzle. Its temperature drops by something like 25 degrees Centigrade. Let the gas which is cooled by this drop escape through an interchanger, in close contact with the coil of pipe, so that it gives up its cold to the gas which is on its way to the nozzle. This produces a preliminary cooling of the gas that is not yet expanded; its expansion then cools it further, and after that it passes away through the interchanger to effect a still further cooling of the incoming gas. The process goes on cumulatively, and the temperature in the pipe and at the nozzle falls without limit, or rather until a limit is reached in consequence of leakage of heat from outside.

But if care be taken to insulate the apparatus well, and make the interchanger so efficient that the temperature of the gas as it finally escapes is only very little lower than the temperature of the compressed gas that is entering the pipe, an exceedingly low level of temperature may be reached at the nozzle, a temperature so low that oxygen or air will stream from the nozzle in a liquid state. The cumulative effect is at first slow, but as the action proceeds the temperature falls more and more rapidly, for the drop due to expansion becomes greater as the gas approaches liquefaction. The early stages may be abbreviated if the compressed gas is cooled to some extent beforehand by other means, as, for instance, by passing it through a pipe surrounded with carbonic acid snow.

A regenerative process in which the drop in temperature is caused by unresisted expansion through a nozzle is better adapted for giving extremely low temperature than one in which the drop is caused by expansion against a piston. The use of a piston at temperatures such as that of liquid air would involve formidable difficulties. A nozzle is easily insulated from its surroundings. An expansion cylinder is not only harder to insulate, but will have heat generated within it by friction. Solvay, using an expansion cylinder to cause the drop, found that the lowest temperature he could reach was –95° C.; beyond this point the losses were in excess of the cold produced. A temperature of 200° C., or even lower, is reached without difficulty, when instead of an expansion cylinder, a throttling nozzle is used to cause the drop.

This principle of regenerative cooling was first successfully employed by Linde for the production of extremely low temperatures, and for the liquefaction of air. In the summer of 1893 he invented an apparatus, shown diagrammatically in Fig. 42. It consists of an interchanger, D E, formed of two spiral coils or worms of pipes, one inside the other. A compressing piston delivers air under high pressure into a cooler, J, where the heat developed by compression is removed by circulating water in the ordinary way. The highly compressed air then passes on through the pipe, B, to the inner worm, and after passing through the coils, expands through the throttle-valve, R, into the vessel T, thereby suffering a drop in temperature. Then it returns through the outer worm, F, and being in close contact with the inner worm, gives up its cold to the gas that is still on its way to expand. Finally it reaches the compression cylinder, P, and is again compressed to go through the cycle once again. Any loss of the air in the system is made good by pumping in more through the stop-valve at A. The tap, V, allows the liquid gas to be drawn off.

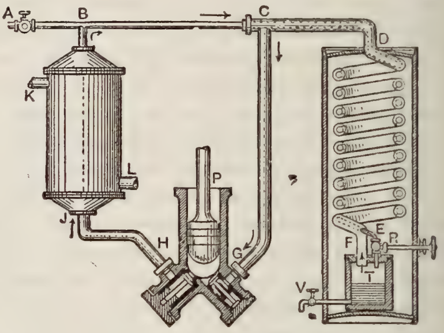

FIG. 42.—LINDE'S REGENERATIVE APPARATUS.

Linde used no preliminary cooling of the air. Starting with everything at atmospheric temperature, he succeeded, in May, 1895, after some 15 hours of continuous operation, in producing so great an accumulated effect that liquid air began to run out of the nozzle. He patented the process in June of that year, and the earliest account of his work, published in English, appeared in October in the *Engineer*.* The novelty and excellence of Linde's invention lie in the combination of the regenerative interchanger with the expansion nozzle as a means of producing what I have called the drop. The regenerative principle had been employed before to accumulate the cooling effect of expansion in a cylinder, but no one had used it to accumulate the small effect which had been exhibited by the experiments of Kelvin and Joule.

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* See also the *Engineer* of November 13 and 20, 1896.

More recently the same method has been employed by Dewar, and has led, in his hands, to the construction of a remarkably simple laboratory apparatus for liquefying oxygen or air. A general view of the apparatus is shown in Fig. 43 and a section in Fig. 44. One flask contains the oxygen, compressed to a pressure of about 150 atmospheres, the other contains carbonic acid. The oxygen passes through a long spiral of small copper pipe. It is in the first place cooled by carbonic acid drawn from the other flask. This preliminary cooling is used to accelerate the action. Linde showed that it was possible to start with air at the atmospheric temperature, and to get it cooled down below the critical point and ultimately liquefied. But by using carbonic acid to cool the air beforehand to –80° C. or so, the action is much hastened, and in about five minutes we find liquid oxygen streaming from the nozzle into the vacuum vessel placed there to receive it. Owing to the presence of slight impurities, it is turbid-looking liquid, but when we pass it through a filter paper into another vacuum vessel it becomes clear and shows the pale blue tint characteristic of liquid oxygen. Following Professor Dewar, we may demonstrate some of its properties. That it is giving off oxygen vapour is shown by dipping a glowing match into the top of the vessel: it immediately bursts into flame. A spiral of lead wire dipped into the liquid has its elasticity so much improved by the extreme cold that a weight hung from it will dance up and down as it would if the wire were of steel. But as the lead spiral recovers its usual temperature by taking in heat from the air of the room its elasticity disappears, and the weight, which it bore easily when cold, begins to draw it out and finally pulls it nearly straight. Another effect of the cold is shown by dipping a sponge into the oxygen and applying it to the back of a piece of paper, coloured with cinnabar: the pink colour of the cinnabar disappears. Another is shown by applying liquid oxygen to some spot on the outside of a flask full of bromine vapour.

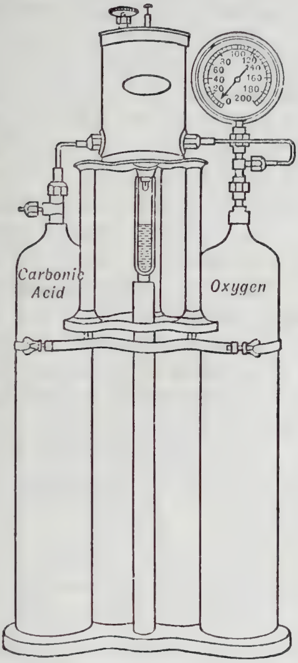

FIG. 43.

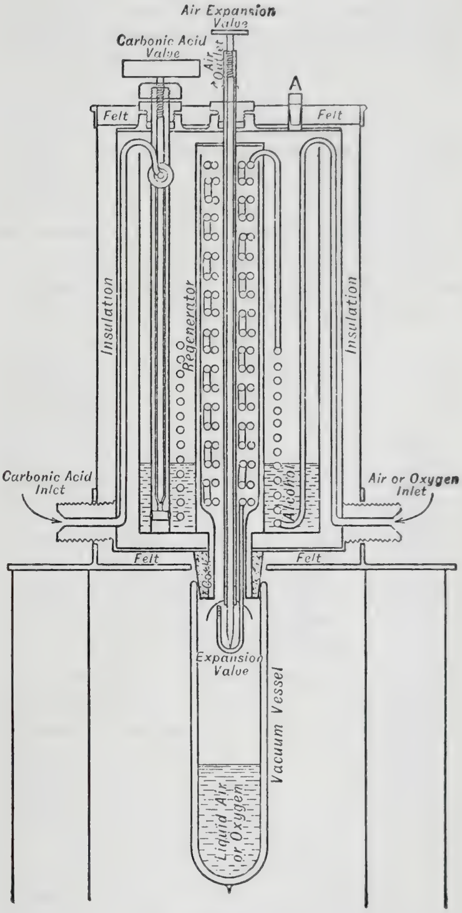

FIG. 44.

The flask loses its orange colour, for the vapour has condensed, forming a solid deposit on the glass at the place that has been chilled. An india-rubber ball dipped into the liquid oxygen becomes so brittle that when it is thrown against the wall it breaks into fragments, and a piece of rubber tubing similarly chilled snaps like a rod of glass when we attempt to bend it. Organic substances, such as an egg shell or an ivory paper knife, when cooled by liquid oxygen, and then exposed to the strong light of the electric arc, show phosphoresence in the dark. A magnet is strengthened by the extreme cold, as the molecular theory would lead us to expect. The magnetic and electric qualities of matter at low temperature have lately been the subject of extended study by Professors Fleming and Dewar.

It is a curious coincidence in the history of invention that some four or five weeks before Dr. Linde applied for his English patent a provisional patent was filed on 23 May, 1895, by Mr. William Hampson, for "Improvements relating to the progressive refrigeration of gases." The text of this provisional specification was brief, and may be quoted in full:—"The usual cycle of compressing cooling and expansion is modified by using all the gas, after its expansion, to reduce as nearly as possible to its own temperature the compressed gas which is on its way to be expanded; with this object all the expanded gas surrounds the pipe or pipes of compressed gas through all their length from the point of expansion to the point of normal temperature, and the length of pipe is sufficient to allow of the fullest possible interchange of temperatures between the compressed and expanded gas."

It is by no means easy to say how much credit should be assigned to this publication. Does "the usual cycle of compressing, cooling, and expansion" mean a cycle in which expansion is performed in a cylinder, as it is in ordinary air machines, or by passing through a throttle-valve, as in machines which use ammonia or sulphurous acid or carbonic acid? Mr. Hampson was endeavouring to get his ideas brought to a practical issue for some years before the date of his application, but he had made no apparatus. Meanwhile, Dr. Linde's invention was produced, complete, and in a form that demonstrated its practicability. Whatever credit belongs to Mr. Hampson takes nothing from that which is due to Dr. Linde. Since then, Mr. Hampson has made experiments at Brin's Oxygen Works, and he informs me that with only 90 or 100 atmospheres of pressure he has got liquid air in three-quarters of an hour without any preliminary or auxiliary refrigeration.

In Linde's first apparatus the interchanger was made of iron pipes, with internal diameters exceeding 1 and 2 inches respectively, and weighing, with the collector and its fittings, fully one and a quarter tons. It was the large mass of the apparatus that made the period of cooking take as long as 15 hours, but once liquid air began to be formed, more than half a gallon (3 litres) was got per hour. With a smaller apparatus weighing half a ton, and with higher pressure, the period of cooling was reduced to five hours. In that case the air to be liquefied was distinct from the air which circulated through the tubes. It was pumped under a pressure of three atmospheres into a separate closed vessel placed within the chamber, into which the nozzle of the interchanger opens. In a third experiment, Linde used copper tubes weighing 130 lbs., and reduced the period of cooling to two hours, one-fifth of a gallon of liquid air being then obtained per hour. We have seen that by the use of lighter apparatus, with the aid of auxiliary cooling by carbonic acid, small quantities ef liquid air may be got in a still shorter time.

APPLICATION OF THE METHOD TO EXTRACT OXYGEN FROM AIR.

It appears likely that Linde's invention may prove important industrially as a means of separating the oxygen from the nitrogen of air. This application of it was made by Linde himself, and is included in his patent of June, 1895. The principle is that when air is liquefied, the nitrogen, being rather the more volatile constituent, tends to evaporate first. Its boiling point is only from 13° below that of oxygen, but this difference is enough to cause the liquid air that is left in the vacuum vessel to become richer and richer in oxygen as the process of evaporation goes on. In the later stages of the evaporation an atmosphere is given off in which the proportion of oxygen is relatively large. Linde's object is to obtain, for commercial uses, such an atmosphere He effects this by dividing the interchanger into two parts, down which the compressed air streams in parallel (Fig. 45) through the two inner pipes, which converge at A. The compressed air goes on through a worm in the receiver, B, passes the throttle-valve, C, and is delivered into B in a liquid state. From the surface of the liquid in B, nitrogen (mainly) evaporates, its evaporation being stimulated by the worm in B, and this passes off through one of the two interchangers, going out at N. The liquid in B becomes rich in oxygen, and this is allowed to pass slowly through the throttle valve, D, into the outer coil of the other interchanger, where it evaporates, gives up its cold to the incoming air, and passes out at O. The gas drawn from O consists mainly of oxygen. The supply of compressed air to the two parts of the coil is regulated by two stopcocks at the top, so that the escaping gases have the same temperature, and that only a few degrees lower than the temperature at which the compressed air goes in. Prof. Linde finds that it is possible in this way to effect a nearly complete separation of the two gases in five cubic metres of air per hour (measured at ordinary pressure and temperature), with an expenditure on the compressing pump of one horse-power.

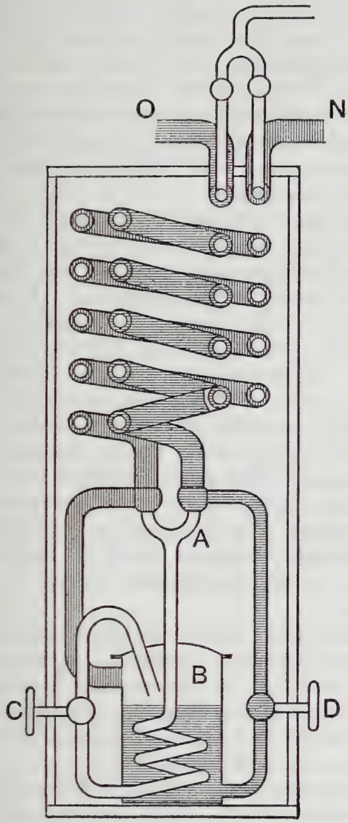

FIG. 45.

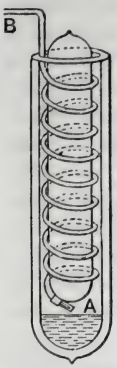

FIG. 46.

Fig. 46 illustrates one of the simplest forms in which the heat interchanger has been arranged by Professor Dewar for laboratory work on a small scale. A single spiral of copper pipe, B A, fits closely into a vacuum vessel, and another vessel or rather globe from which the air has been extracted fits closely into the spiral. The annular space between the two is formed into a helix by the spires of the tube, and up this helix the expanded gases pour after issuing from the nozzle at the bottom of the tube. The vacuum vessels shelter the coil against conduction of heat either from outside or from the middle space.

Fig. 47 shows the arrangement used by Professor Dewar to get a hydrogen jet. The hydrogen, highly compressed in the flask A, passes first through a coil cooled by carbonic acid snow in B, then through another cooled by liquid ethylene in C, and goes on to the third vacuum vessel D, which contains a long coil serving as an interchanger. It expands at the bottom of this coil through a pin-hole opened by the screw-valve at F, and escapes at E after passing up in intimate contact with the coil. The critical temperature of hydrogen is about −235° or −240° C, and it is some ten degrees colder when boiling in the atmosphere. We may conclude that this apparatus has achieved a temperature which is short of the absolute zero by only 25 or 30 degrees.

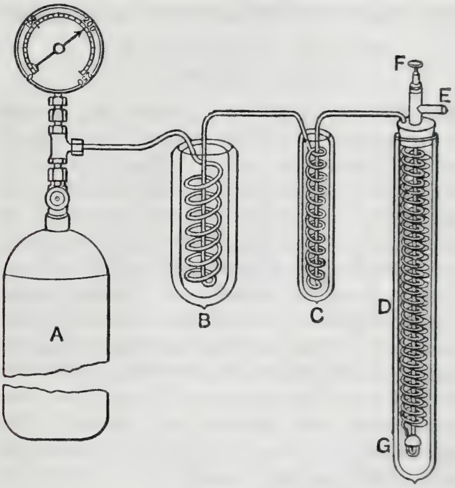

FIG. 47.

CONCLUSION.

In conclusion, I have to express my hearty thanks to many gentlemen who have given me information to be used in these lectures. I owe much to Professor Schröter, and to Dr. Linde. Mr. Windhausen and Mr. Osenbrück have also kindly furnished particulars of their inventions. Coming nearer home, I am under many obligations to Mr. Sterne, Mr. Lightfoot, Mr. Hesketh, and Sir Alfred Haslam, to Sir Frederick Bramwell and Mr. Graham Harris, to Mr. Donaldson and to Professor Dewar, whose assistants have also kindly co-operated in showing experiments.

The refrigerating industry, if I may judge by my experiences whenever I have asked for information, is a trade without secrets. Makers are willing to show everything, and apparently to tell everything, justly confident in each case that their own wares have good points which only need to be known to be appreciated.

Miscellaneous.

THE PROVINCE OF BRITISH COLUMBIA.*

By C. E. Perry, M.Inst.C.E.
(Member of the Society of Arts).

The province of British Columbia lies between the 116° and 126° of West longitude, and extends from the 49th to 60th parallel of North latitude. It has coast lines on the North Pacific of nearly 1,000 miles, and an average width of over 400 miles. Its area is nearly 400,000 square miles. It is nearly four times as large as Great Britain and Ireland, and twice as large as either Germany or France, Austro-Hungary or Spain. It is the same size as Egypt or German East Africa, nearly six times greater than the State of Washington, nearly five times greater than the two Dakotas, Minnesota or Idaho, and over three times greater than Montana or Oregon. This immense territory is intersected by four distinct and nearly parallel mountain ranges called the Rocky, Gold, Coast, and Vancouver ranges.

The Rocky Mountain range has an average breadth of from forty to sixty miles. Quoting from Dr. Dawson:—"It, the Rocky Mountain range, is built up chiefly of a great series of Palaezoic rocks. There are more or less isolated basins of bituminous and anthracite coal and deposits of copper and galena ores. Its south-western side is defined by a very remarkable straight and wide valley, over 700 miles in length, extending from the 49th parallel to the head-waters of the Peace river, forming the catchment basin for the heads of the largest rivers—the Peace, Fraser, Columbia, and Kootenay. Gold placers have been worked at several points along the valley, and valuable discoveries of various ores are now being made in the vicinity. It forms Nature's highway between the south and north portions of the province along its central and eastern boundary.

"The Gold range is composed of a number of irregular mountain chains. In its southern part these are named the Purcell, Selkirk, and Columbia, in the north the Cariboo, Omineca, and Cassiar mountains. The Gold range as a whole constitutes the most important metalliferous belt of the province. The richest gold fields are closely related to it, and discoveries of metalliferous lodes are reported in abundance from its explored portions. They include highly argentiferous galena and other silver ores, and auirferous quartz veins."

Between the Gold and Coast ranges lies the interior plateau of British Columbia; a saucer-shaped basin falling inland from the Coast range to the plateau country of the Peace river. It has an average width of over 100 miles, and a mean elevation of 3,300 feet above sea level. It is intersected by a number of streams and rivers, and is dotted with lakes and ponds. Good grazing and agricultural land exists in its middle and southern portions. To the north it is generally heavily wooded. Dr. Dawson says:—"As a mineral region it is destined to take high rank particularly in the precious metals. Placer deposits of gold have been worked in a number of widely separated localities. Platinum is abundant in the Smelkameen on its southern boundary."

The Coast range begins near the mouth of the Fraser river, and follows the trend of the broken and indented coast line. Its average width is 100 miles. The mountains of this range are very rugged and generally heavily timbered. Copper, iron, and silver have been found in the rocks of this range.

The Vancouver range appears in Vancouver and Queen Charlotte islands, and is continued southward to the Columbia river by the Olympian mountains of the State of Washington. Northward it is submerged. Gold placers and gold bearing quartz, iron, copper, and lead ores, and its immense coal deposits have for years been its most important and valuable features.

Although British Columbia cannot be said to have a large combined area of agricultural land, there are many hundreds of thousands of acres well adapted for farming purposes in the province. Valuable timber exists along the principal river valleys, and on the mountain slopes.

The fisheries supply the Old World markets with a large quantity of salmon and other varieties which abound in almost inexhaustable quantities.

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* This sketch has been largely compiled from the pamphlet written by Dr. Dawson, F.G.S., director of the Canadian Geographical Department, entitled "Mineral Resources of British Columbia."

The means of communication have been in the past chiefly by the great waterways that seem to have been placed by Nature for that purpose. Mountain trails, waggon roads, and railways permit of ready access to the southern, eastern, and central portions of the province. Luxurious transport is afforded by the Canadian Pacific, its branches, and other railway system; while magnificently appointed steamers on the Columbia and Kootenay afford ready means of egress and ingress to the United States and the Atlantic and Pacific seaboards.

Along the coast line, well-appointed steamers ply between the various ports, from cities of Victoria and Vancouver to Alaska. China and Japan are reached by the fine steamer service of the Canadian Pacific Railway running in connection with their railway system. The mining centres of the southern portion of British Columbia can be reached in ten or twelve days from London, with ease and comfort.

The metalliferous belt of British Columbia, according to Dr. Dawson, has a length of over 800 miles, and adding to this the northern extension of the same belt beyond the 60° parallel, we find that within the boundaries of Canada, its entire length is between 1,200 to 1,300 miles, this being almost precisely equal to the whole length of the same region included in the United States, from our southern boundary line to the northern boundary of Mexico.

Says my eminent authority, Dr. Dawson, "I feel no hesitation in recording my belief that the northern moiety of the Cordillera will ultimately prove to be susceptible of a development corresponding in importance to that which has already been attained in the southern."

"Everything which has been ascertained of the geological character of the province as a whole tends to the belief that so soon as means of travel and transport shall be extended to what are still the more inaccessible districts, these also will be discovered to be equally rich in minerals, particularly in the precious metals, gold and silver." Dr. Dawson dates the discovery of gold in British Columbia to 1851, but there are records of small discoveries on the main land as early as 1836.

The total output to the present year, 1897, from report of Minister of Mines of the province is:—

	Dols.
Placer gold	57,704,855
Silver	4,028,224
Building stone	1,200,000
Copper	254,802
Coal	33,934,427
Lead	1,606,427
Lode	2,177,869
Other material	25,000
Value of total output	100,931,604

This is equal to £20,200,000. Of this amount the past two years, 1895-96, have contributed $7,146,425, or, say, £1,430,000.

OMAHA INTERNATIONAL EXHIBITION.

Arrangements are now in progress for holding an International Exhibition at Omaha, Nebraska, U.S., from June to November, 1898, under the title of the Trans-Mississippi and International Exposition.

It has been granted recognition as a national and international exhibition, under an Act of Congress approved by President Cleveland in June, 1896, with privileges for the admission of foreign exhibits free of duty, the right to strike memorial medals through the United States mints, and all other privileges heretofore granted to international expositions. The Act also pledges the United States to participate in the Exposition by the erection of suitable buildings, and to place a Government exhibit therein. This Act carried an appropriation of 200,000 dollars to defray the expenses of Government participation, but it was not until June, 1897, that an item in the Civil Sundry Bill, in consonance with the Act passed a year previously, was adopted by Congress and approved by President McKinley. The Secretary of the Treasury has issued official orders covering the regulations under which foreign exhibitors may participate, and these have been sent to the United States Consuls throughout the world.

The site is an area of 200 acres on the north side of the city. This is to be laid out as a park, and six principal buildings are now in course of erection. These are to be devoted to agriculture, art, electricity and machinery, mines and mining, manufactures and liberal arts, and an "auditorium."

The Exhibition is controlled by a corporation known as the Trans-Mississippi and International Exposition, with a capital of 1,000,000 dollars. In addition to stock subscriptions, it is stated that revenues aggregating not less than 1,000,000 dollars from various sources have been assured.

The management of the Exposition is vested in a directory of fifty members, with an executive committee of six department managers.

The Commissioner-General for Europe is Mr. Dudley Smith, whose address in London is Low's Exchange, Trafalgar-square.

THE CAUSE OF ARSENICAL POISONING BY WALL PAPERS.

By Thomas Bolas, F.C.S.

It has long been recognised that arsenical wall papers do serious mischief, but the work of Gosio and of Emmerling seems to have cleared up that mystery which has surrounded the matter. Certain moulds, including the very common *mucor mucedo*, have a remarkable property of decomposing arsenical compounds with the evolution of volatile products containing arsenic, and the highly poisonous character of volatile arsenical compounds, coming into the system by way of the respiratory organs, is well known. Arsenious acid is, even in small quantities, a highly antiseptic substance, and poisonous to moulds, so the throwing off of the arsenic in a volatile form may be an effort of nature to cast out the poison. The arsenical copper greens, and other colouring matters containing arsenic, are still used, and, paradoxical as it may appear, it is by no means improbable that the most dangerous wall papers are those containing a mere trace of arsenic, as when the quantity is large the moulds cannot exist. Traces of arsenic may come into wall papers from the imperfect washing of vessels used to contain the more highly arsenical colours. Now that boric acid is very cheap, the old and perhaps forgotten suggestion of Bolley to use a precipitated borate of copper as a green pigment in place of the arsenicnl green deserves attention. Bolley's green is prepared by taking two parts of blue vitriol (crystallised cupric sulphate) and three parts of borax in separate quantities of cold water and mixing; after which the precipitate is washed and dried. Dyed and printed fabrics now very frequently contain traces of arsenic.

ARGENTINE POPULATION AND IMMIGRATION.

The population of the Argentine Republic has lately been returned at 3,952,000, which is 3·56 inhabitants per square mile. In 1869 it stood at 1,737,023. The foreign element of the country, principally Italian, amounts to one-fifth of the whole. It is estimated that there are some 550,000 pure Italians in the country, and perhaps over 1,000,000 born of Italian parents. The French population has been put at 125,000; German, 85,000; and British, 55,000. In the province of Santa Fé, the wheat-producing section of the country, there are more foreigners than natives, the figures being, according to the recent census, foreigners 345,493, and natives 318,361. The principal immigration of the country comes from Italy, that country sending, in 1895, 65 per cent. of the whole number of immigrants. They are from the better classes of Italians, largely from the north of Italy. The net immigration to the Argentine Republic for 1895 was 46,783 persons; in 1894, it was 54,720; and in 1893, 52,007. For the last five years the total has been 220,000 arrivals. The amalgamation of foreigners of all nationalities is steadily going on, and will in time make a considerable change in the social and political conditions of the country. The three principal cities are Buenos Ayres, the capital, with a population of 663,000; Rosario, with a population of 93,000; and Cordova, with a population of 42,000. It appears from the recent census that in the capital there are 181,393 Italian subjects, 80,352 Spaniards, 33,185 French, 6,838 British, 5,297 Germans, and 3,057 Austrians.

General Notes.

SCHOOL OF ART WOOD-CARVING.—This school has been re-opened at the Central Technical College, Exhibition-road, South Kensington, after the usual summer vacation. One or two of the free studentships maintained by means of funds granted to the school by the institute are vacant. To bring the benefits of the school within the reach of artisans a remission of half-fees for the evening class is made to artisan students connected with the wood-carving trade. Forms of application for the free studentships, and any further particulars relating to the school, may be obtained from the manager.

PARAGUAYAN TEA.—In a report to the Foreign-office, quoted in the *Board of Trade Journal*, H.M. Consul at Villa Asuncion states that *Yerba-maté*, or Paraguayan tea, is the most valuable article of export from that place. There are two classes sold, but it is only in the manner of preparation that they differ. The kind known as "Mboroviré" is merely dried over a furnace, and then beaten into small pieces with sticks. The "Molda" goes through the same process, but it is afterwards ground in a mill. The export duty on the former was increased in 1895 from 30 c. paper to 10 c. gold, and on the latter from 25 c. paper to 9 c. gold per 10 kilos. The revenue derived from this source in 1895 amounted to 471,668 dols. (£16,845). The *yerba* forests, called *yerbales*, were formerly the property of the State, but most of them have been sold, and are now in the hands of a few capitalists and companies. The Industrial Paraguaya Company, which owns about half the *yerbales* known to exist in the country, exports annually about 400,000 arrobas (4,512 tons). The total quantity of *yerba* exported during the past year is estimated at about 9,024 tons, and the average price per arroba (25 lbs.) was 11 dols. 50 c. paper (7s. 8d.)

THE RICE CROP IN KOREA.—The food of the people of Korea is rice, meat and vegetables being mere accessories. In the extreme north where rice cannot be grown extensively, wheat, millet, and beans are used as substitutes, but wherever rice can be had it is always preferred. Korean rice is of excellent quality, some of it being considered almost equal to the best Japanese. Consul Allen says it is difficult to estimate the amount of rice grown in Korea, as no proper statistics are kept, but the actual consumption is estimated at about 2,000,000 bags per annum, or 320,000,000 pounds. In former years the surplus was stored in Government granaries against a bad year, the old rice being issued the next season, bag for bag, for new rice. In 1886 the export of rice from Korea began in a small way and has increased year by year, subject of course to the condition of the yield. The native method of cleaning is by pounding in stone or wooden mortars and separating the chaff by winnowing. This leaves much gravel with the rice and causes injury to the teeth in eating. Lately, a number of fanning mills have been introduced from Japan and Japanese have started a few crude steam rice mills.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The Report of the Proceedings of the International Congress on Technical Education, held at the Society of Arts in June last, has now been published—price 3s. 6d., by post 3s. 10d., and can be obtained on application to the Secretary, Society of Arts, John-street, Adelphi, London, W.C. The volume consists of 307 pages, and contains a report of all the papers read and the discussions, with appendixes giving lists of officials, delegates, and others taking part in the Congress.

Proceedings of the Society.

CANTOR LECTURES.

DESIGN IN LETTERING.

By Lewis Foreman Day.

Lecture I.—Delivered May 3, 1897.

The subject of the course of Cantor Lectures I begin to-night is really the relation of lettering to design—

Art in the Alphabet !—that should have been my title : it would have conveyed, I think, better than "Design in Lettering" the actual task I have set myself—which is to discuss the subject of Lettering from the point of view of Art—and only from that point—for it is the only one from which I have any right to speak.

I shall have, of course, to refer to the harcæological and palæographical sides of the question ; but I promise you it shall be in the briefest possible words ; and I wish here, once for all, to make it clear that I lay no claim to the slightest authority on anything but the point of view of design—and even on that point I wish it to be understood that I am not presuming to lay down the law to artists, but only expressing my individual opinions. I do not wish even the younger members of my audience to attach more weight to my words than may be due to the interest I have always taken in this subject and the years I have given to its study. It suits my temper best to speak my mind frankly, and unguardedly—and I don't want anyone to think that my most uncompromising assertion means more than that, *that* is precisely how the thing strikes *me*.

"Design in lettering !" We are bound to assume that, in the first instance, there was none ! The alphabet was not designed : it grew. Precisely whence it came it would be rash to say—palæographers differ—but there is no doubt it came from the East as all culture did.

The Phœnicians, it used to be said, first invented alphabetic writing. They were, as everyone knows, *the* traders of antiquity (as we ourselves are the traders of to-day), and no doubt they spread the art of writing over Europe. But neither is there any doubt that the Egyptians were before them, to say nothing of the Chinese. The Chinese apparently arrived, quite independently of the Egyptians, at an alphabet of their own. Those, however, who should know best seem to agree in thinking that Egypt led the van. Certainly it showed Europe the way.

The letters of the alphabet are neither more nor less than symbols of sounds. Writing was in the first place figurative—that is to say picture writing,

Drawing in fact preceded writing, or was the form writing first took. Primitive man knew no other way of conveying the notion of man, beast, or thing, than by making a rude sketch of whatever it might be. That, then, is the first stage of writing, the *figurative*—a simple, but rather cumbrous way of recording speech, of transmitting it, that is, by glance of eye instead of word of mouth.

From that merely figurative writing to *symbolic* expression is but a step. It requires no great stretch of the imagination to let, we will say, the sword stand for war, the pipe for peace, the lion for courage, the skunk for cowardice, and so on.

Not that I mean to imply that these particular symbols were used in this sense by the Egyptians—I refrain purposely (in my entire ignorance on the subject of Egyptology) from pretending to say the sense in which they used the familiar signs of vulture, beetle, serpent, and so on. It is enough for our purpose that, by the acceptance of images such as these *as symbols*, it first became possible to convey in writing abstract ideas.

The stock of ideas which could be so conveyed was, in the nature of things, limited, you could express a fortified town by a tower—but *what* town? Moreover, when once a *thing* stood for an *idea*, it became necessary to distinguish between the representation of it designed to express that idea, and the representation of it to express merely the thing itself. How was the reader to know, whether by a serpent the writer meant eternity or simply a reptile? It is conceivable that a polite note asking for the loan of a hatchet might be taken as a declaration of war.

As the best symbolic writing could appeal only to people who had ideas in common—it would puzzle one, to-day, to invent a symbol which should convey to the Italian tradesman a notion of what we mean by "fixed prices"—the wider the dealings of a people, the more they would feel the need of some more elastic means of expression. How for example express proper names, or things not readily distinguishable by the eye—say sugar from sand, glass from precious stones—and so with many a commodity in which a trade might be carried on. (There is an ominous sound about the word "trade"—but we must give it its due—and there is no doubt it is largely responsible for the spread of so much culture as may be implied in the use of written language.) Well, this need of more elastic expression—ever more and more pressing—was supplied by the use of signs to express, not merely things, no longer even ideas only, but *sounds*. There, with signs for sounds, begins a really scientific system of writing.

How man can possibly have conceived the idea of devising such a system is more than one can understand: the daring of it is tremendous; but of course its originators had not the faintest notion of the perfection to which in the course of ages it was to be carried. It began, after the manner of things destined to take root, modestly; and for awhile the alphabet, though phonetic, was still pictorial.

The new departure consisted in making a sign stand for the sound of a word, and no longer for the word itself. It so happens that in the language of all primitive peoples words are usually monosyllabic—it was so in Egypt—a sign therefore stood for the sound of a syllable, and eventually for the first part of the sound, for the first *letter* of it in short. It is as though they had started with the notion that

"A was an Archer,"

or rather that an Archer should be A—and so forth through the alphabet—no matter whether it took 16 letters or 52, or 500, to express the sounds employed in the language.

An Archer answers very well for A—but the delineation of the archer makes demands upon powers of drawing with which not every one is gifted, and in any case it takes time. Why not, therefore represent the archer by his bow: that is easily drawn, and not easily to be mistaken. Similarly, if the Ox stood for O, or the Stag for S, the beast might just as well be suggested by his horns only—and so on to the end of the alphabet.

Writing is always a sort of shorthand: inevitably the signs are reduced to their simplest expression, become mere signs, as unlike the thing which may have suggested them as a man's signature—which is yet honoured by his banker. Enough if it conveys that what we are meant to understand: the business of a letter is to convey a definite sound.

We arrive, then, by an obvious process of "degradation," as it is called, of natural forms, at an alphabet of practically quite arbitrary sounds, the alphabet as we know it, and have known it for a couple of thousand years and more. (I don't quite know why we should call it degradation—"fit treatment," "natural selection," I should rather call it.)

You must bear with me for a few moments whilst I endeavour to trace back the characters we use to their origin.

We know them (in a sense) so well that we never think to ask ourselves what they mean or how they came to be. But it is of no use attempting to discuss the letters we employ without realising first of all how we came to employ them: rightly to understand their forms, we must understand how they came about. The story of their evolution should be interesting. At all events it is an essential part of our subject.

We get our alphabet, as you know, from the Romans—we speak of it to this day as Roman to distinguish it from gothic or black letter. The Romans got it from the Greeks, or, if not precisely that, from the same sources whence they derived theirs.

What we know for very certain is that the Greek, Etruscan, and old Roman alphabets are all very much alike. They resembled one another, that is to say, in the number of letters they contained, in the sound-value of those letters, and in the form they took. These letters were originally only 16 in number; and that seems to have sufficed always for the Etruscans—the race died out before ever it had need of more. The Greeks, it appears, grafted on to the old Pelasgic or native alphabet (whence-soever that may have been derived) certain new letters necessary to express new words (involving new sounds) which they borrowed from the Phœnicians. Naturally they took those letters from the Phœnicians also. These same Phœnicians probably adopted from the Egyptians signs sufficing to express the sounds in their own language—without caring, or knowing perhaps, anything about the pictorial origin of such signs. They accepted them as so many arbitrary expressions of sound-values; and there was nothing in the world to prevent their modifying them, therefore, until they had reduced them to the very simplest and most convenient form of expression. That is what they did. And so it comes about that we to-day appear to be directly indebted to ancient Egypt for at least some part of our alphabet, far removed as it may be from the hieroglyphics of the Pharoahs. But that is by the way, as well a long way off. For our present purpose we need not go further back than to ancient Greece.

The Greeks had no longer (as the Egyptians had) any signs to represent syllables, that is to say combinations of vowels and consonants; but they retained certain compound consonants, most of which they adopted from the Phœnicians. These the Romans dropped. At first they used, instead of them, the two consonants ch, ps, which expressed as nearly as possible the equivalent sound of the Greek Χ, Ψ, and so on.

And then, perhaps, they devised a single letter for a sound which until then had been expressed by two—F for example instead of Ph—Q instead of Cu.

The 16 letters common to Greeks, Etruscans and Pelasgians were Α Β Γ Δ Ε Ι Κ L Μ Ν Ο Π Ρ Σ Τ Υ. The Phœnician letters next added were Ζ Θ Φ Χ. After that we get Η for ee, Ω for oo, Ψ for ps, Ξ for ks.

The early Roman or Latin alphabet differed very little from the Greek. The latest comers in it were G H K Q X Y Z. Once *printing* was established, changes in the form of the type were necessarily very gradual. Possibly they have been on the whole in the direction of clearness and legibility. Certainly they have not been in the direction of beauty —which, however, I am bold to contend, is perfectly compatible with sternest usefulness. And we have arrived to-day at a period when everyone is so familiar with the printed page that, although he may be prejudiced against any modification of it, and resent it, there is no danger of his not being able to read it in any improved shape we might devise.

Modern type is based on manuscript forms. Those MSS. forms were modified by the scribes with a view always to ease in writing. Whatever was difficult or took long time to write fell naturally out of use. In printing, that concerns us no longer—one shape is as easy to print as another; and it might be worth while to restore some obsolete features, now that we have not to write the letter. At any rate I think it is time we looked over the alphabet—took stock of it as it were—with a view to perfecting it as *printed type*, without too tender a regard to its descent. Letters, like the men who use them, must stand to-day on their own merits.

Our first business with the alphabet is to make it work smoother, to make reading easy. That will be done by developing whatever is characteristic in each letter, by curtailing, and if possible lopping off, whatever there may be in it which allows us to confound it with another. The needful thing is, in the case of each individual letter, to emphasise its individuality, to make it unmistakeably itself. And at the same time there is no reason why reading should not be made pleasant as well as easy; beauty has also to be borne in mind. It goes without saying that that must on no account interfere with use, but there is not the least reason why it should. Beauty does not imply elaboration or ornament. On the contrary, the qualities of simplicity, dignity, character, which in the name of art we desire, are precisely the qualities which in name of practicality are equally demanded.

The preliminary, however, to any doctoring of the alphabet, any surgical operation, however necessary, any safe prescription even, is that doctors should understand the patient.

I propose therefore, not precisely, to dissect the alphabet (though it is dead enough), but to explain to you, as far as I can, the comparative anatomy of lettering—and I have prepared a series of diagrams* which I think will enable you better to distinguish what is essential to the letter, and what is not. They are not beautiful—but should be helpful.

You will notice the resemblance between the Coptic and the Greek letters. The Coptic alphabet is, in fact, only a variant upon the Greek. The Copts, you know, were the Christianised Egyptians—and when they accepted Christianity they adopted the Greek alphabet—just as the Turks took the Arabic character together with the Koran—and in the 6th century, when the new faith was firmly established at Alexandria, Coptic writing supplanted the old Egyptian. The Coptic alphabet is therefore Greek, except for seven extra signs, taken from the ancient demotic alphabet to express Egyptian sounds for which the Greeks had no equivalent.

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* Apart from these diagrams and their description the following remarks appear of course disjointed.

In its adaptation to Latin language Greek gamma or G becomes C. G is in fact almost equivalent to *hard* C. To the not too subtle ear the two sounds are like enough to pass one for the other—just as *soft* C may be made to do duty for S. When G came to be used as a separate letter, distinct from C, then C in its turn was used for K—though K did not go quite out of use.

There are points of resemblance again between our alphabet and the Runic. Runic is the name given to the writing of the priests of Northern Europe, and especially of Scandinavia. It is no doubt ancient. The legend is that it was the invention of Odin. If so, Odin must have derived it from some ancient Greek or Roman source, if we are to judge by internal evidence. Certainly it was in use from the time of the first intercourse between Scandinavians and Romans. Christianity forbade its use, and with the triumph of Christianity it passed out of currency. But it affected our Anglo-Saxon writing somewhat.

The Greek H stands for EE; but at the beginning of a word it answered the purpose of the aspirate. The Romans used it for the aspirate only—that is to say, practically just as we use it now, namely, for H.

The letter J did not exist either in the Greek or in the ancient Roman alphabet. It is equivalent of course to i i. Place one i over the other and you get a long $\overset{\mathrm{I}}{\mathrm{I}}$. Eventually the initial developed a tail, and became J. Towards the 15th century the initial I was pretty generally written J.

The Greek ϒ (upsilon) becomes the Roman V—whence the confusion, until quite recent times of the letters U and V, which, you know, were used indiscriminately. They were interchangeable—you might use one or the other—both, if you liked, in the same sense, in the same word. It was not until the 10th century that the custom arose of reserving V for the beginning of a word, and elsewhere using U.

Ω (omega) stands for oo. And in the minuscule form looks like it, *shows* its derivation; but in the end it is used for uu, or W. It appears that in some Greek dialects it is used for ou. It is quite certain that in the 9th century omega was *written* precisely like a W. And when you come to think of it the sounds are very nearly alike. Take any word beginning with W, and change the W into double o, and then try and pronounce it—say, not WHY, but OOHY. Why, its much the same thing!

Lecture II.—Delivered May 10, 1897.

I propose now, in the first place, to show you just a few pages, or parts of pages, of lettering showing the more decided steps in the *progress* of the alphabet.

Our *printed* type takes, as you know, two forms—a larger and a smaller, major and minor, or as printers put it, capitals and "lower case"—because the small letters, being those most continually in request, are kept for convenience, nearest at hand—in the lower part, that is, of the case from which the compositor, so to speak, feeds himself.

Our *written* character takes the form of a "running" hand—and is known by that name.

Now, the printer's "lower case" or "minuscule," as it is also called, is practically the book-form of running-hand, except that the letters are quite separate, and not conjoined, as they are in what pretends to be only the hand of the ready writer, and does not claim to be beautiful at all.

The earlier form, whether of Greek or Roman lettering, was the capital—those more or less square letters, with relatively few curved shapes, which were most convenient to cut in stone or engrave on metal. It is in fact the *monumental* style—adapted to, and, what is more, inspired by, the chisel or the graver.

Even in the 16th century version of it on the screen (in which the rounded D and other details show Gothic influence) you see at a glance how eminently fit it is for its purpose; you realise at once that that is inscription. Manuscript writers adopted for book writing a different character, or rather they adapted the square capital letter to more ready execution with the pen—and so evolved a rounder kind of letter which is known by the name of *uncial.* The word "uncial" is supposed to be a corruption of "initial," but the use of uncial letters does not support that derivation. I show you an instance of exceptionally beautiful small or round hand Greek writing, "cursive" as it is called, in order that you may compare it with the more stately *uncial* writing. This form of letter was commonly used in Greek MSS. of the 10th century.

The uncial form of writing is intermediate you will see between the monumental writing and the "current" hand of the ready writer. It is, if not the step between the two, a compromise between them—no matter which. What it concerns us to know is that calligraphy took that form—which goes to explain many a later form of letter widely differing from the original square type.

It does not so much affect the modern printer—but it is the form of letter from which the artist who prefers his own handiwork to that of the printing press has probably most to learn.

Even when the Romans used, as they sometimes did, the square capital form in MSS. they did not confine themselves to the severely simple shapes which came naturally to the lapidaries—

The unequal strength of the lines, the thickening of the strokes at the ends, and the spurred or forked shapes they take, all speak of the pen—not the steel pen of course, nor yet the more supple quill, but the reed pen—rather blunter than a quill, but pliant enough, and less given to spluttering—and it did not tempt the writer to indulge in unduly thin upstrokes.

The smaller *uncials* you will see are own brothers to the Greek letters just shown.

A further example illustrates another form of square capitals employed by the Romans in MSS. of the 5th and two following centuries. They are known by the name of "rustic" capitals—not that there was anything rustic about them in our sense of the word; but the Latin word was used in the sense of free and easy, *sans gène*. The character of the writing, that is to say, is not so formal as would befit the town: it is a kind of country cousin: it stands, let us say, for the Roman capital in a loose coat and a soft hat. The rustic writing shown is of the 5th century. The characteristic points about it are that the vertical strokes are all very thin, and the cross strokes broad. These cross strokes take the form of a kind of tick, tapering at the ends; and similar ticks are used to emphasise the finishing of the thin strokes. The A has no cross stroke; but is like an inverted V. F and L rise above the line. The I wants knowing —*then* you can read it. The T and L are none too easily recognised. That all of this is pen work is, I think, self-evident. But, as before said, the more usual form of penmanship is the uncial letter.

Roughly speaking, capitals represent the first accepted form of letter engraver's or carver's work, whether Greek or Roman.

Uncials stand for MSS. writing, scribe's work, growing rounder by degrees; whilst the smaller minuscule letter, our "lower case," was evolved out of the running hand of the business; as distinguished from the literary, scribe. This last was not used by the ancient Romans, and it was not till towards the 8th century that it was thus, as it may be said, reduced to order.

Running hand hardly concerns us. "Cursive" it is called: it might be called discursive—it is so apt to run wild. It tells us less of the artistic progress of lettering than of the caprice or carelessness of the individual writer.

There were various ceremonial versions of the running hand employed by the writers of Papal Bulls and Royal Charters—"diplomatic" hands they are called, because diplomas were written in them; and some of these, and the so-called "Chancery" hands, are highly elaborate if not ornamental; but they are so illegible, so unlike familiar forms of writing, that it would be hopeless to try and discuss them briefly, and it would serve no useful end.

With the decline of the Roman empire came naturally the demoralisation of the Roman character—capital or uncial—and just in proportion as Rome ceased to be the one centre of the world, and the Frankish and other nations rose into importance, so their writing began to show signs of nationality. At the loss of some refinement we now get variety of character. By the beginning of the 8th century we get distinctly national styles of lettering.

To subdivide these styles so minutely as some learned antiquaries do is simply to bewilder the poor student by their multitude. The important European races were, the Latins, the Franks, the Teutons and Anglo-Saxons, and the Visigoths; and so we get the Lombard, the Frankish, the Teutonic and Anglo-Saxon, and the Visigothic types of writing—all of which eventually merge themselves in what we call Gothic, though we may still distinguish between Italian, French, German, English and Spanish Gothic.

I will show you specimens of some of the earliest national styles. First the Lombardic—that is the term commonly used to describe the form of lettering which prevailed in Italy from the 8th to the 11th century.

It might be taken to imply that the style of it was in some sense the invention of the Lombards. That was not so at all. They were just long-bearded conquerors, and invented nothing. The style was not even confined to northern Italy; but it happened first to be developed there, and so all later Latin writing (after the empire) was called "Lombardic."

Uncial writing, I told you, was transitional between square "caps" and rounder pen-forms. The Lombardic shows a further stage of transition. The penman has not quite made up his mind between straight lines and curved; he hesitates between the square-lined M and N and the rounded forms. Eventually he decided for the rounded form, which in its later development we distinguish by the name of Lombardic capitals.

In another form of Lombard writing, "*Lombard brisée*" as the French call it, is foreshadowed the "black letter" or Gothic form. Its name is justified by the broken back of the letter—in which, as I said, you see the beginning of that later gothic "lower case" which we call black letter.

Our own "lower case" we get more or less directly from Charlemagne, who was crowned you know in the year 800. He found, perhaps his friend the Pope told him, that writing by that time had degenerated to a state unworthy of a mighty emperor, and accordingly he ordained its reformation. He went so far as to compel bishops and other important personages who could not write decently, to employ scribes who could. In this way he revived the small Roman character which we eventually adopted for our printed type.

The scribes of Charlemagne (and for some time after him) did not yet manage to fashion very satisfactory capitals. They still mixed up letters all of one thickness with others in which thick and thin strokes, or diminishing strokes, were used in a most illogical and awkward way—indicative, of course, of a period of change. But they did arrive at a satisfactory and very characteristic rendering of minuscule lettering. A conspicuous feature in it was the elongation of the longer limb of the l p g q f d. *Tails*, that is to say, came into fashion, and long ones, as much as four or five times the length of the body of the letter. We get now also the long s—f, though the t does not rise much above the line, sometimes not at all.

That elongation of the up and down strokes is characteristic of Frankish and Visigothic lettering generally. It occurs even in the case of capitals, as in the headlines of the 10th century MS. on the screen. There, you see, the I the H and the L rise high above the heads of their fellows, whilst, on the other hand, the V-shaped U in the word Opvsculum is reduced to more than modest proportions.

Visigothic lettering, of which that is a good example, shows, it seems to me, usually a trace of Moorish influence, betraying itself, to begin with, in the liberties taken with the *proportion* of the characters: the Moors, remember, had by that time overrun the whole of Spain.

You will see in the alphabets on the screen the rather freaky character of Anglo-Saxon lettering—sometimes mechanically square in form, sometimes exceptionally flowing and even frisky. Anglo-Saxon lettering, I should say, was affected by lingering traces of an obsolete alphabet derived perhaps at some remote period from the Gauls, which, to judge by internal evidence, must have been something like the Greek—but I need not go into that; letters so unlike ours do not much concern us.

A couple of pages of a 7th century copy of Gospels show the character of the Saxon minuscule lettering. There is a curious twist in the long stroke of the b and l which here does not rise above the line at all.

By the 13th century the Gothic style had formed itself. In the next hundred years or more it perfected itself. At the end of the 15th century it was still flourishing—flourishing was the word literally, and in the 16th it was sometimes all flourish. I show you some late German letters. It takes an expert to read them. Some of them happen to be upside down. It is no easy matter to say which!

But I am getting on a little too fast. I have two or three examples of "Lombardic capitals," as they are called, to show you. These were used as initials. In their simplest form they were just in red; often they were filled up with linework in blue, or more elaborately illuminated with gold and many colours; but it is the form of the letters themselves to which I wish to call your attention now. The swelling and bulging of the lines is as characteristic as the spring of their tails and other extremities. To this period belong also the "closed" letters characteristic of 13th and 14th century Gothic writing.

Lombardic capitals were not used only for initials; inscriptions were written in them entirely; in fact it was not till the 15th century that inscriptions were commonly written in minuscule letters. Observe that this is not pen writing. It is done with a brush, and there results a very distinctive character: the letters are fatter than pen letters.

Contrast the Lombardic capitals with a rubbing from a Flemish brass, also of the early 15th century in which you see there are *no* capitals at all. The even perpendicularity of the straight strokes gives at a glance the character distinguished as "black letter:" there *is*, of course, relatively much more black about it than there would be in an inscription in Roman character.

Another Flemish Gothic brass shows the association of similar lettering with capitals—The simplicity of these Gothic capitals argues that it belongs to not too late a Gothic period. Further inscriptions in Lombardic capitals are shown in the stained glass from the Sainte Chapelle at Paris, undoubtedly of the 13th century.

You will see that the letters are sometimes joined together. We have abandoned that kind of thing, except in the conjunction of Æ and Œ diphthong, and writing is all the easier for it; but there are ornamental possibilities in the linking of letters not to be overlooked.

The next diagram on the screen is by way of reminder that the Gothic scribes used two forms of smaller letter—or rather that their manner varied so that it presents forms very different in appearance. According as the writer considered ease of writing he approached the rounder of those types, the more *cursive*. If regularity was his first thought he adopted the latter, the more straightbacked. This latter form went rather out of fashion for awhile—but it was revived by the *printer*—who saw in it what he could best imitate.

The page of late German Gothic lettering shown, has quite a national twang about it; it is a noble bit of black letter, strong and manly as one could wish. But there is something rude in its strength when you compare it with the Italian MSS. which follows. That is strong in a simpler way, more refined, more perfect, not so Gothic perhaps. There is an elegance about Italian Gothic lettering, see the capitals for example, which is not characteristically Gothic. The difference of nationality is very plainly marked in these two contrasting specimens.

By way of prelude to some examples of printed type, I will show you just two or three specimens of 15th century penmanship. The first are from German missals of towards the end of the 15th century; both of them are excellent and not too florid. The capital letters in the upper one you will see are rather frisky, but being distinguished from the rest of the type by their colour, those tails would not cause confusion in the ranks. Even the crosses introduced at erratic intervals, certainly in a very decorative way, would not so much interfere with the wording in red as they do in the photograph. In the lower instance you may note how decorative is the use of the four heading lines of the page in letters three or four times as big as the rest. Compare with these the Italian MSS. next shown, rather earlier in date—1450—but *Roman* in character, you see.

I need not explain to an audience such as this how in the 16th century (and much earlier in Italy) the classic manner of design generally was revived, and with it, of course, the style of lettering. Enough to note that at the time of the introduction of printing the two styles were in use for MSS., and so two styles of printed type arose.

The type we use nowadays has come about in a more or less accidental way. In the first place it was a copy of MSS. forms. That was inevitable. Possibly printers were anxious to palm off their printed books as MSS. But apart from any such intent on their part, their text was bound to follow the written page—or no one would have been able to read it.

The printed psalter, of which a page is shown, bears obvious resemblance to the two MSS. specimens shown three slides back. This was printed by Schæffer in 1457. It is the first book with date, and the earliest specimen of printing on colours: the big initial B is in red and blue.

The black letter and the Roman types, as the printer first conceived them, are both shown on the screen together, for comparison. The topmost of the two is from Schæffer's Bible, 1461. My friend Mr. Emery Walker considers it perhaps the best of the black letter founts.

The lower, by Jensen, 1470, is one of the best Roman. There again we have the heading lines of large type. You see when you compare the two that the black letter *is* blacker.

A supplementary slide shows you on a rather larger scale specimens of the same two founts with another between them of intermediate character—not so angular as the one, not so round as the other That is by Sweynheim and Pannærts who were the first to print in Italy. All these are obviously very much in the likeness of MSS. writing.

The Gothic lettering next shown is French and not so aggressively Gothic as some writing and printing of the period. It is of the year 1486.

A more rigidly Gothic type is the specimen by Wynkyn de Worde of Westminster, 1486. That is English, you see, and is typically "black letter."

A further example of English work is from Caxton's "Dictes of the Philosophers," the first book printed in England.

That will be enough of type printing. I have shown examples enough to illustrate the variety in it.

When I was a boy, I remember, I thought there were so or so many alphabets; I had no notion as to how many, but I had no doubt about there being a fixed number; and I have a very distinct recollection of hesitating to buy a book of alphabets (which I coveted) hoping to find one which would include them *all.* It did not occur to my youthful mind that in the year 1300 or 1400 the recognised forms of lettering had never yet been stereotyped, and that each individual scribe was at liberty to play variations on the well known alphabetical tune. That is just the difference between lettering ancient and modern, that we are not allowed to play variations; and that is why our types are so monotonous.

In the case of type-printing that must be more or less so. But I think it might be less: we need not go on copying copies of copies of copies of copies, from which all the virtue of vitality and freshness has died out. That is how we arrive at the Victorian newspaper type. Compare it with the early founts, and ask yourselves if *that* is any credit to this year of *Jubilee?* *I* don't feel very jubilant about it. Let us found ourselves at least upon the best types; and let us go straight to them for inspiration. We have got to *go on.*

Pedants want everything to be fixed—but nothing is fixed until it is dead. Then let it be decently buried. Life is in movement. We have long since given up the idea of perpetual motion—but that is the secret of it—life. And that is the evidence and sign of life—motion. The question is, are we alive?

I have alluded to the influence of the way writing was done upon its shape and character, more especially in reference to the implement employed in writing. I must illustrate that a little more plainly, for it is of infinite importance in design.

The earliest writing was most probably scratched with a point upon whatever was handiest — skins, palm-leaves, the bark of trees, and especially upon clay—a material which, when it was baked, was more lasting than stone. We have to-day at the British Museum any number of clay tablets or Babylonian "bricks," covered with minute and most voluminous inscriptions.

To the left of the screen is what purports to to be the most ancient inscription extant (B.C. 4500). That is a very rude drawing taken from the *Daily Chronicle,* but you can see that the signs are all *scratched*—there is no doubt about that. The smaller inscription at the top of the screen, to the right, is seven or eight hundred years later. In that you see the *wedge shapes* from which the cuneiform writing of the Assyrians takes its name. That is described, you see, as a "brick *stamp,*" but the drawing is too rude to show how it was done—whether stamped, scratched, or cut. If, in scratching on firm clay with a sharp instrument, you begin with a *dig,* and, as it were, *drag* the tool along, you get a more or less wedge-shaped scratch — and that may very well be the way the cuneiform lettering came about; but the British Museum "bricks" (as they are called) are so precisely and sharply defined that they must almost certainly have been cut.

You will see in the various cuneiform inscriptions lower down, on the same side of the screen, divers wedge-shaped or arrow-headed characters, taken from what are said to be facsimiles of sculptured writing. But the more common Ninevite form, as found in the famous sculptures which we have at the British Museum, is neither forked nor rounded (as these reproductions have a tendency to be), but consists, as in the diagram I give you, of, for the most part, merely three-sided digs into the stone. In fact it is "chip carving" of the simplest kind, born and bred of the chisel.

From that to the simple Greek or Roman capital, as square as well could be, is not far. Early Greek inscriptions on granite are sometimes not much more than scratched in the stone.

The small Greek character on the famed Rosetta stone is *mere* scratching. Larger and deeper-cut lettering is still typically chisel-work though no longer simply chip carving.

The writing with a stylus on tablets of wax was naturally blunt. Penwork at first was also much blunter than modern writing—owing partly to the pen used (a reed) and partly, it seems, to the texture of the material on which it was written. At all events the early writings on papyrus (Egyptian, Greek, Latin) are bluntish—the lines rather equal in thickness, the points not sharply turned, but rather rounded.

The Arabs wrote with a reed pen held more or less *horizontally* so as to hold the ink. The *paper* or papyrus was held at an angle. It was in writing the Roman letters with a reed pen that the mediæval scribes gave it its Gothic character. When *quills* (which hold the ink better) came into use it enabled the Italians to develop their minuscule.

In the divers specimens of early Egyptian hieratic writing shown you will see there is considerable variety of character. The lettering in the darker scrap of papyrus is unmistakeably the outcome of the brush, and, curiously enough, it is written in vertical columns, just as Chinese and Japanese writing is—which also is brush-work. By the way, the Chinese had also an almost perfectly rectangular form of writing—which was their monumental manner. The inscription to the left, below the last mentioned, proclaims itself penmanship. Two inscriptions look as if they might have been dug out of clay with a round-pointed instrument. More likely they are cut in stone which has been weather-worn.

I have amused myself by designing an alphabet, near enough I think to ordinary Roman lettering to be unmistakeably readable, based on the idea that it can be cut in the simplest and most direct way on fairly hard stone. The letters are shaped, that is to say, with deliberate view to their direct and easy expression with the chisel. I take the Assyrian cuneiform character, and its invariable use for inscriptions to be cut, as proof of that being a convenient form of letter for cutting. It is noteworthy that Assyrian inscriptions painted on bone are not cuneiform, whilst those cut in bronze are.

The suitability of the straight-backed Gothic letter to engraving on brass is plainly shown in the engraved brasses of the 15th century, and you get a precision in the detail which is characteristic of the graver.

In some of these it is the background of the letters which is cut away, whilst a well proportioned band of bright brass holds them together. The taller letters cut into this. The letters themselves are in some cases slightly engraved, so as to suggest that they consist of straps which turn over. That is a tune upon which the writers of the 15th and 16th centuries played many variations.

Gothic still, but very different, is the French black letter shown. Clean as the work is, there is not that metallic precision about it, though the incised letters are very squarely formed. The fact is they are cut in slate; and you see it in the comparatively soft lines of the curling tops and tails of the taller letters.

A yet more beautiful inscription, also French, is yet more suitably treated. There is no reason why in soft stone the letters should be rigidly square; and these are not. There is here more the freedom that you get in penwork—of which you yet trace the influence. Still it is not penlike, but obviously and beautifully what it is, viz., cut in.

The painted inscription in Lombardic capitals is very different; but you never suspect this of being cut either in stone or brass.

You can see again the influence of material upon design in the big D on the screen. That is a simple block for printing or stamping on to linen an initial (afterwards to be embroidered ?) It is made for French peasants, and sold in market places for two or three sous—the workman himself a peasant. It consists of strips of thin flat wire driven into a chunk of deal, roughly sawn across the grain, so that the metal-tape easily finds hold. But see how simply the design follows the process employed, the easy curves which lend themselves to it. The type of the letter is common-place; but it is the common-place type best suited to that way of working. So with the added decoration. The workman (and those to whom he appealed) would probably have liked the sprig of foliage more natural; but the wire would have it so; he followed its promptings, and was something of an artist, almost in spite of himself.

I have attempted to design an alphabet especially suitable to wood. The suitability of strapwork to wood-carving is shown in instances innumerable of Elizabethan, Jacobean, and especially Henri II. wood-work. The slightest modelling on the surface of the slightly raised pattern is for many purposes quite enough. There, at all events, is lettering adapted to the simplest expression in wood-carving; and that simple expression dictated its design.

The Arab *penmen* took great pride in their penmanship; and their writing shows the wonderful elasticity of the pen. They seem to get out of a reed pretty much all that a brush will give. One is reminded of brushwork by the characters on the screen, but they are yet more like broad penwork—though here woven in silk; and very beautiful decoration this *neskhi* character makes. The Arabs had also a squarer *cufic* form—which I take to have been originally the monumental or sculptural form.

The letters on the old English sampler of the 17th century are clearly adapted to needlework, their angularity, as well as the peculiar form of that angularity, is begotten of the canvas on which the work is done, and characteristic of a simple class of needlework. Very different is the other needlework example. The needleworker has the choice of two very opposite kinds of lettering, the one rigidly square in outline, following the meshes of the canvas, the other carefully avoiding anything like a right line, which it is difficult to get right except in the way last shown. This flowing letter is well adapted to working on a material of which the mesh is not apparent. There is good reason for here avoiding the square line; and even flourishes are excusable.

The alphabet in Gesso is suggestive of the way it is done. It is easy with a long-haired brush and a thick creamy composition of glue and plaster to trace fairly even, fat, bluntish lines. Of such lines I have devised an alphabet —naturally of rather a curly character. To have tried for sharpness would have been foolish. Just such an alphabet as this (it might be much more elaborate) would lend itself to execution in raised cord (single or double) sewn down or "couched" upon a textile ground.

Two more examples and I have done. The first a 16th century version of the Greek alphabet, just that you may see its simple, square, and clean cut lines. Comparing that with the lettering on the coins next shown it might seem to you that the die sinker had, say in the coin at the bottom of the screen nearest to me, set himself to elaborate a much more ornamental form of letter, rounded at the points in a curious way. But, he had no such ambition. That simply happened so. The fact is the artist worked with a drill and a wheel; and in cutting the very short strokes of which the letters are made up, he would be likely with the wheel to overshoot the mark. It was a safe plan to drill holes at the points and then to engrave a line from hole to hole. From that comes a character which he did not think it worth while to efface.

It is time now I came to an end. I shall have an opportunity in my last lecture of referring again to the influence of the tool upon the alphabet. Enough for the present if I have impressed upon you how inevitable that influence is, and the character it gives to design.

Miscellaneous.

THE TIMBER RESOURCES OF SPAIN.

Very little attention is paid in Spain to the cultivation and care of forests, although such attention is much needed in almost every province, not only to supply the requirements of trade and industry, but also to adorn the landscape, to invigorate the soil and to preserve the crops from the devastations of droughts and floods. As a rule such forests as do exist in Spain are remote from the littoral towns and cities, and they are therefore of comparatively small value except as fuel for local purposes, inasmuch as the railway facilities for transportation are limited and rates are high. According to the United States Consul at Barcelona the imports ef wood into Spain amount to about £1,458,000 in value annually. Of that sum £531,000 are paid for staves, most of which come from the United States. The remaining £927,000 are employed in the purchase of pine from Finland, Sweden, and the United States; fir from Canada, beech from Hungary, elm from Austria, mahogany from Mexico, walnut from Italy, and from the storehouses in Havre, Bordeaux, and Marseilles considerable quantities of cedar, ebony, and sandal wood. That a great variety of trees can be easily grown in Spain may be inferred from the fact that the following species are to be found in the country and apparently thrive there. The palmetto (*el palmito*) found in Andalusia, Murcia, Valencia, and Catalonia. The spruce fir tree (*pinabete*), a tree very common in France and Germany, and very useful in building, is found in Spain only in Aragon and Catalonia. The pine (*pino*) is of six kinds in Spain—*el pino pinonero*, used in naval construction and in carpenter's work and quite abundant in Andalusia and Castile; *el pino silvestre*, which grows to a height of 90 feet and is seen in the north and west of Spain; *el pino negro*, a wood easily polished, growing in the north of Aragon and Catalonia; *el pino negral de Cuenca*, which grows in nearly all the mountainous regions of Spain; *el pino carrasco*, which is not so tall as the other kinds, and which makes good boards, being found principally in Murcia and Valencia, and also in Catalonia and Aragon; and *el pino negral de Segovia*, a dark pine, very common throughout the Peninsula, but not very strong nor elastic. The elm tree is of two kinds—*Ulmus campestris* and *Ulmus montana*—and is seen in many parts of Spain in valleys and near rivers and in the promenades of some cities. The wood is hard and elastic and is used in making carts and machinery. The white poplar (*alamo blanco*), a very common tree in all parts of Spain and much used by carpenters. The yew tree (*el tejo*), hard and compact, and found in Sierra Nevada, in the Pyrenees, and in Asturias. It is much used by turners. The black poplar tree (*chopo*), light in weight and serviceable as poles and handles and in the manufacture of paper. This is one of the few trees that are cultivated in Spain. The beech tree (*haya*), which grows to a height of 120 feet and forms large forests in the mountains of Navarre, Asturias, Logrono, Leon, and Santander, and grows in Burgos, Saragossa, Lerida, and Vizcaya. The chestnut (*el castano*), is useful in making staves, boards, doors, and windows. It is seen chiefly in Galicia, Asturias, Santander, Vazcongadas, and Catalonia. The oak (*el robla*) grows in every province of Spain and is a favourite for naval work, machinery, furniture, carts, casks, and barrels. The cork tree (*el alcornoque*), is a great source of wealth to Spain and forms large forests in Gerona, and is abundant in Cordova, Algeciras, Tarifa, Malaga, and Estremadura. As the forests of Gerona are near the coast, immense quantities are easily exported from there. During the year 1895 the exports to the United States alone amounted to £63,000 in value from Gerona, and to £43,000 from the other cork districts of Spain. Some of the forests are natural and some are cultivated; all thrive equally and are probably the finest in the world of their kind. The evergreen oak (*encina*), is also a very common tree in nearly all the provinces of Spain. Its wood is hard, compact, and strong, and is used in making many small articles. The birch tree (*abadul*), although ordinarily found in cold climates, grows well in the Pyrenees and is seen as far south as Madrid. The wood is used for domestic utensils, and its branches make good hoops for casks and barrels, as does also the wood of the hazelnut tree (*avellano*) which flourishes on the eastern coast of Spain. Wood that can be easily polished is also found in the various provinces of Spain, such for instance as the walnut (*nógal*), juniper (*enebro*), white mulberry (*la morera*), wild olive (*acebuche*), and the pear tree (*peral*), the apple tree (*manzana*), the orange tree (*naranjo*), the almond tree (*almendro*), and the lemon tree (*limonero*). As yet, says Consul Bowen, no great efforts have been made to test the eucalyptus tree in Spain, but there are some fine specimens of the globulus species in Catalonia and also in Malaga. The Consul adds that France is the only continental country that appears to attach sufficient importance to the advantages to be derived from the cultivation of trees, and her experiments with the eucalyptus have already attracted considerable attention in Spain, and seem destined to encourage the Spanish people to take a livelier interest in enriching and beautifying the vast tracts of their territory.

TRADE GUILDS IN CHINA.

Consul Charles, of Chinkiang, says, in his last report, that though labour is cheap in Chinkiang, the workmen seem able to dictate their own terms. Neither masons nor carpenters begin work in winter much before 9 a.m.; in summer they knock off work for a long two hours' siesta in the middle of the day, and at all seasons of the year smoke, drink tea, and rest whenever it suits them. According to the regulations of the Builders' Guild, wages, if the men find their own food, are 180 cash (about 5¾d.) per diem. These wages are supplemented in the case of skilled labourers by their apprentices' wages, which are paid at the same rate. Apprentices are bound for three years, and as evidence of the scarcity of skilled labour it may be mentioned that on many works at least half the men are apprentices. As accidents are frequent in the trade, and especially among unskilled hands, the parent of the apprentice has to give an engagement in writing, holding the boy's master free from all liability for loss of life or for injury incurred during the term of apprenticeship, but a present is expected in case of an accident. No interference is permitted, under the rules of the Builders' Guild, with a customer engaging any builder preferred by him. Touting for employment is punishable by a fine, to be fixed in public meeting. No outside firm is allowed to work until it has joined the guild, and received a certificate, the fee for which varies. Assistants or foremen who endeavour to obtain business on their own account from persons for whom their masters work are liable to a heavy fine. Masters have to pay the guild at the rate of about one-twentieth of a penny per diem for every man employed by them, to form a fund to meet subscriptions for canal works, &c. A similar tax is levied on assistants to meet the cost of festivals, illuminations, &c. If trouble occurs between a builder and his *employés* and work is stopped, no other labour can be engaged until all outstanding accounts are settled. Breaches of the rule are punishable by fine levied in public meeting. Attendance is obligatory at meetings called to fix the quota to be paid towards subscription funds. Disputes between masters and men are not allowed in the guild house. They must be arranged in the tea houses or opium shops. The building trade has been spoken of as a guild, but there are really only five trades in Chinkiang which are recognised as important guilds. These are the silk and piece-goods, the banks, the sugar, the rice, and general dealers. Members of these guilds are taxed in proportion to their business, to meet the various subscriptions required from the guilds towards canal works, festivals, &c. The funds of these guilds are also devoted towards the relief of widows and orphan children of former members. There is no fixed rule as to the amounts given in such cases, but they are left to the discretion of the managing committee. There are many other small guilds of the same status as the Builders' Guild, but the power of such bodies over their members is imperfect, and even in the five larger guilds the sugar trade is the only one which is looked upon as thoroughly capable of enforcing its decision by complete combination among its members. The general dealers are not unfrequently able to dictate their own terms to steamer companies, but the other guilds are weakened by having too many members to secure unanimity. The whole power of trade in China rests in combination and monopoly. This has been weakened by foreign influence, but every attempt at developing new branches of trade leads to an attempt to return to the old principles by seeking government protection against competition.

THE PRODUCTION OF SALT.

The quantity value of salt produced in the United Kingdom, and used in brine during the five years ended 1895, are as follows:—In 1891, 2,043,571 tons valued at £976,824; 1892, 1,956,524 tons, value £861,401; 1893, 1,924,029 tons and £735,222; 1894, 2,235,912 tons and £763,629; and 1895, 2,173,253 tons and £709,751. The corresponding figures for 1896 are not yet available. In commenting upon the returns of salt production in the United Kingdom, it is stated in the report of the Salt Chamber of Commerce for 1896, that the ammonia soda process has by its increase deprived of some portion of their previous markets those who produce salt for sale. The total trade of the United Kingdom exhibits an increase, the slight relapse in 1896 being due to exceptional freight circumstances. The export and coastwise figures, taken together, of the last five years, are as follows:—In 1892, 958,306 tons; 1893, 949,785; 1894, 1,066,483; 1895, 1,080,601; and 1896, 1,022,617 tons. No fresh discovery of rock salt or brine has occurred in this period, except the interception of salt in the Isle of Man during some borings for coal; nor has there been in any part of the world any noteworthy expansion of the existing manufacture. Occasional efforts have been made in South America and Spain, and elsewhere, to utilise long known deposits of salt which are hopelessly remote from railway or ocean, from labour or fuel, or otherwise devoid of commercial importance. In the production of the United Kingdom there has been little change except some re-adjustment to topographical and other economic advantages. All the salt districts of the country, especially the most advantageous, have been developed far in excess of either their respective local or foreign demand. The natural result has ensued, prices no longer, says the report of the Salt Chamber, offer any inducement to the enterprise of increasing the plethora. Germany having a few years ago reached the limits of her own consumption, has been pushing the salt into the markets of neighbouring countries, and with less success into more remote parts of the world. Her strength lies in the facilities and cheapness of her inland navigation and ports of shipment. In the United States the inflation of native production, caused by the indiscretion of English manufacturers in 1889 and 1890, has been partially corrected, but reports still show considerable struggles between the chief districts producing in excess of demand. The Red Sea has provided more salt for India. It is of inferior quality, but like the Hawburg article, is mixed with English salt, and goes into consumption at a lower price. When Eastern freight, and consequently the price of English salt, is at a normal level, the market of these lower grades are limited. The Indian Government has powers under Adulteration Acts to restrain this mixture, but has not yet seen fit to exercise them.

THE GERMAN TEXTILE INDUSTRY.

The result of last year's census of mechanics and working people in the German Empire, shows that there are over 1,000,000 persons employed in the textile industry alone. The exact number is 1,017,112, comprising males and females. In the census of 1882, 932,592 persons was enumerated. Since 1883 the fact may be of interest, says the United States Consul at Glauchau, that there has been a decrease in the number of male *employés* from 582,070 to 552,230, a reduction of 29,840. Their places have been filled by females, whose number has increased from 350,522 to 464,316 in the same space of time, showing that its textile industry is especially adapted to women, who appear to be neglecting all other branches of labour, particularly that of domestic service, to go into the factories. As a result of this growing industry and occupation for so many thousands of human beings, the factories are being remodelled and constructed on the most approved plans as to sanitary surroundings, and with the comfort of the *employés* as an object. More than half the total number of persons engaged in the textile industry are employed in the dress goods and cloth-weaving branch of the industry, in the different departments of weaving, spinning, reeling, spooling, twisting, wadding, &c. The remainder are employed in the manufacture of hosiery, fringes, and trimming, comprising knitting, weaving, bleaching, dyeing, pointing, finishing, &c., in all branches of which both men and women are employed. As a proof of the development of the German textile industry during the last thirteen years, it may be stated that in 1882, 410,370 tons of raw material were imported for working up in this branch of trade in Germany, and in 1896 the figures reached 808,300 tons.

General Notes.

CENSUS OF EGYPT.—Particulars of the population of the chief Egyptian towns, as obtained by the census of May 31st, 1897, have been published in the *Revue d'Orient*:—

	1897.	Increase since 1892.
Cairo	576,400	201,562
Alexandria	319,767	88,371
Tantah	57,288	23,538
Assiout	42,076	10,301
Mansourah..........	36,247	3,044
Zagazig	35,475	15,660
Port Said	35,303	18,748
Damanhour	32,163	8,810
Damietta	31,241	2,805

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CANTOR LECTURES.

DESIGN IN LETTERING.

By Lewis Foreman Day.

Lecture III.—Delivered May 17, 1897.

It is of no use trying to evolve new alphabets out of our inner consciousness. No one would understand us; and we want to be read. Originality is perhaps never the thing to seek: it comes: we are original or we are not; but least of all is it to be sought in lettering.

While the alphabet is alive there will be changes in it; but they must inevitably be gradual, we can only creep on to new forms. Practically, all that is left for us to do is to take one or other accepted type of alphabet and make in it such modifications as we may deem desirable, being careful that they do not too much interfere with its legibility.

The more general opinion is, I know, that nothing should interfere with its legibility at all. I quite appreciate that point of view; and yet I maintain the right of art to interfere with its legibility on occasion—and, on occasion, to interfere with it considerably.

It all depends upon the occasion. There are times when wording is introduced into design with the deliberate purpose of hiding it more or less, just as speech may be said to mystify. And, just as in speech it is more to the purpose to suggest than to demonstrate, so in lettering there are times when a hint is more to the purpose than an advertisement. True, advertisement is the order of the day, and in advertisement there is no such thing as modesty; but there still are occasions when the almost obsolete thing called reticence is more becoming. If, for example, on a wedding gift (the modern equivalent of a marriage *cassone*), I choose to indicate in wording the occasion of the gift, there is no need so to shape the words that he who runs may read—they are not addressed to him—it is enough that they are there, decipherable to whom it may concern.

More than that, it would be an offence if they were too plainly readable. The more tender the sentiment conveyed in the words, the more inevitable it is that they should be expressed in something like a whisper. Here, then, I say, a certain mystery about the lettering is *essential*. Even where that is not quite so, it may still be permissible. If one were introducing the Lord's Prayer into church decoration, the first two words, "OUR FATHER," would so infallibly put the Christian reader on the track of the inscription, that there could be no possible difficulty in following even the most intricate lettering.

I do not know what liberty the Arabs took with the name of Allah, which they introduced so liberally into decoration; but they could hardly take too much. There seems a sort of reverence in veiling the characters employed. So with the inscriptions borne by angels and other holy personages in mediæval design—the Mediæval pictures were not posters, though we try to make posters mediæval. There was no fear that anyone would misinterpret the words on the scroll ingeniously decorating the background to a representation of the Annunciation—one reads them by anticipation—and the artist was free to make all and every decorative use of them.

There are occasions then when lettering offers considerable scope for art, and where something may well be sacrificed, nay, should be sacrificed, to considerations purely decorative. For the most part, however, all that the artist can do is to take, as I said, some accepted type of lettering (he needs to choose it with judgment) and *better* it—but without in the least making it less legible. If he knows what he is about he may possibly make it more legible. And it is because I thought it would be helpful to him in this to be reminded of the descent of lettering, and the phases it has gone through on its way to what it is, that I have ventured to discuss the subject at what may have seemed to you some length.

His type of letter once selected, what can a man do with it?

He can take liberties with its proportion—make it taller or more squat;

He can compress it or spread it out;

He can incline it;

He can draw it in thick lines, or in thin, or in lines of intermediate strength;

He can draw it in thick and thin and intermediate lines.

The implement employed, the chisel, graver, brush, pen, affects the form of your lettering—if you will only let it (I insisted upon that last week), but, except in the very simplest, rudest, and most elementary forms of lettering, you are early confronted with a difficulty, a difficulty which seems to have been felt from very early days indeed, in fact from the moment when men were no longer content with mere scratching, or with simple incised lines naturally blunt at the ends.

So soon as a man began to use the chisel he felt the need of a square cross cut to finish the lines of his letters. In the case of a broad stroke there was no need for this to extend beyond the width of the stroke itself. In the case of a narrower one, it was obviously easier to make it extend beyond the stroke; then it did not matter if the carver overshot the mark a bit. Besides, one chisel would do for that. He would not want a smaller one for the end cuts.

This finishing off the broad line by a projecting cross line is technically called truncation, though literally that only means "cutting off." Slight but appreciable difference in character results from the angle at which the strokes are cut off.

In working with a pen this difficulty of finishing off the stroke occurs only in the case of very bold lettering. In smaller writing the strokes naturally take pen-shape. They start square and gradually diminish, or *vice versa*, or they thicken in the middle according to the pressure of the pen, which it is difficult to keep quite equal from end to end of the stroke.

It should be observed that the pressure is not naturally in the middle of the stroke, but at one end; you don't get the symmetrical Roman O which is chisel-bred; you get the Gothic **O**. That is the pen-born shape.

I say that the evensided O came of working with a chisel—*not* that it is easier to cut than the other, but it is *as* easy; there was nothing to *prevent* symmetry, which accordingly was sought. It is rather futile to try and get that shape with a pen; much better let the pen have its way; and its way is otherwise. You get most out of your tools by going with them: it is rather stupid to go against them.

In bolder writing, even with a pen, the necessity for truncating the thick strokes occurs. You cannot with one stroke of the pen make a thick line which begins and ends square. It wants trimming; and the easiest way to trim it is by means of a fine cross-stroke extending beyond its width, as in the letter I, which, observe, helps to preserve and to accentuate the regularity of the line of lettering—for which a writer worth the name naturally has a care. The broad stroke (we are still talking of penwork) being rather loaded with ink, this fine cross stroke would be inclined in crossing it to drag a little of the ink with it, rounding the angle to the right of the latter. The obvious way of rectifying that is to round the opposite angle also—and so we have the familiar finish I.

You can soften the angle at which the cross line joins the stroke until it disappears, and the stroke appears to be curved on either side, dilates, to use another term, at the ends. (Historically we arrive at that in Lombardic writing as early as the 8th century.)

Anticipating this dilation, the penman eventually makes strokes in which the elementary straight line altogether disappears. Further elaborating he gets the familiar in 13th century work. Devices such as forking the ends, or breaking the outline are the beginning of fantastic elaboration to which there is no end.

With the use of thick and thin strokes comes another difficulty. Which shall be thick, and which thin? The scribes were a long while making up their minds on that point, and they contrived some very awkward combinations. The solution we have at last come to is probably the best that could be found. I don't think we need bother ourselves much about trying to improve upon modern practice in that respect; it has been a case of the survival of the fittest.

The use of thick and thin strokes necessitates intermediate or graduated strokes there is then no other way of treating the *curved* lines, which are intermediate between the two. If the thick strokes are truncated the thin lines appear to want accentuation at the ends; and so the "serif" runs all through the alphabet.

It is all-important that the letters of an alphabet should be in conformity, should be treated, that is, systematically; and that is the reason why I said that we begin by choosing a type of existing letter. There is no reason why we should not cross the breed in lettering, and so improve the stock. But the thing must not *look* hybrid—When that occurs the artist has failed. Here, again, a man may do what he can. Effort is justified by success. We have to make our creation look as if it must be so, and could not well be otherwise.

The philistine *will* talk as if type were in every respect better than handwork—truer and more perfect! Truer, perhaps, it may be, in the sense of being more mathematically exact—but not necessarily so truly uniform in effect; for the unyielding letters of the type-founder come together as best they may, and if they come awkwardly he can't help it. The writer can, and I think he should.

I am quite ready to admit that many an artist who ventures to introduce lettering into his design, does it ill, does it so carelessly, or is so easily satisfied with very indifferent penmanship, that one is bound to confess that of the two evils hard and fast letterpress would have been the lesser. On the other hand I contend that an artist who has been at the pains to learn to write, can, if he aims at what the pen or brush will do, and does not enter into foolish and ineffectual rivalry with the printing press, not only do what that cannot do, but do better.

Looking at any good collection of early printed books, you are astonished, each time afresh, at the beauty of the page. But if you go from that straight to a collection of fine manuscripts (the comparison is easily made in the King's Library at the British Museum) you realise that, after all, printing, even such printing as was done by the great printers, was a makeshift. It is a makeshift, I know, which we must make up our minds to put up with—and it is our business to make the best of it; merely petulant complaint is childish; but when occasion does occur, by all means let us have the real thing; and don't let us be persuaded by readers of print who have lost all appetite for beautiful writing, that there is no flavour or artistic savour in it. It is not good MSS. but their bad palate which is at fault.

Having perfected machinery, we are doing our best to make ourselves into machines. Until that happens (which God forbid!) man's hand is still the best—in art at all events; and were it not the best, it would still have the charm of character, that individual quality for which the public, brought up on printed type, has no relish. Print, with its mechanical smoothness and precision, has gone far to distort the modern ideal of lettering, just as photography, with its literalness, has degraded the artistic ideal generally. People are apt to resent as a sort of impertinence anything in lettering which the printing press cannot do. There is offence to them in the unfamiliar. Really the impertinence is in a makeshift thing like type usurping any kind of authority in a matter altogether beyond its jurisdiction.

It is possible, in the time I have, only to hint at what may be done in the way of modifying the shapes of letters.

I have roughly indicated on a diagram the kind of liberties it is possible to take with the construction of the letter A, but only indicated, for I have not shown the small "a" nor the later Gothic forms at all. It makes all the difference whether the two limbs of the letter are sloped at the same angle, or whether the top is crossed, or whether curved lines are used. Great also is the effect of varying the position or the angle of the bar, or of breaking its shape.

I have only just hinted the new possibilities which lie in curvature.

A group of Gothic A's, taken at random from early printed books, shows what variations can be played upon a letter of a *single type*. It is interesting to see the individual character of each letter there, notwithstanding the strong family likeness between them.

Gothic letters lend themselves to more variety in design than Roman—perhaps, because they are not so perfect in themselves. I don't say they are not more interesting on that very account. Perfection palls, and some of the Gothic forms are very beautiful. The Roman form is fixed—perhaps because it is classic! Or is it that it is classic because it is fixed? In those few Gothic ways of rendering the letter A, what variety is there! And by what slight changes that variety is achieved!

I have tried in a simple alphabet of my own to give some character to the letters without doing much violence to familiar forms. The difficulty is to design an alphabet legible enough and yet not quite commonplace. It makes all the difference in the world of course whether you are designing an alphabet with a view to type printing, to momumental or other inscription, or use only as initials. "Design" is almost too pretentious a word to use in connection with this kind of variation upon orthodox forms. One can do very little that is new.

A more florid version of the alphabet obviously of *Gothic* derivation, without being deliberately based upon any "authority," may lack repose; but then it is not meant to have it. It is permitted to be playful sometimes—and even skittish!

In the alphabets so far referred to, the ornamental design is in the construction of the letters. That seems to me to be the principle to go upon. And it was followed by the best designers. But, at the same time, as you will see in the group of letters next shown, the letter itself could be further decorated.

Various ways of doing that are shown there. In one case the letters are as it were split into ribbons in their thickest parts, and ingeniously interlaced. In another the whole thickness of the letter is filled in with foliated ornament. In others again the ornament is compelled to take the shape of the letter—with more or less success.

A common device is to make the letters break out into foliage. Frequently also letters comparatively simple in design are just forked and cusped at the extremities, and pierced at their thickest parts, the ornament being extraneous to the letter, interlacing with it, piercing it, or merely filling up the space behind it. In the shading of certain letters you see the beginning of evil. A more wicked practice still is what I may call the rustication of the alphabet. There we scent the rococo.

In an elegant interlacing alphabet from an Italian copybook of the 16th century, the artist has first drawn his letters in outline, and then made the outlines loop and interlace, so that they *occupy* the thickness of the letter and at the same time break the formality of its shape. Yet not too much—everything is in that—the form of the letter is sufficiently preserved; and it is always a form worth preserving.

An ingenious elaboration of the lower case "black" letter, also from an Italian writing book, is quite a good specimen of the "ribbon" letter. When once the carver or engraver began to consider the broad strokes of his letters as straps, and to suggest by ever so slight a cut that they were turned over at the ends, it was inevitable that he should arrive eventually at this kind of thing—to which the square black letter lends itself so easily. The result is florid but fanciful: one could not stand much of it at a time; but in moderation it is a distinctly pleasing excess—And it is admirably done.

Some highly ornamental letters were designed by Israel van Meckenen, late Gothic of course. The broad divisions of the letters filled with flamboyant German Arabesque, tell light upon a dark ground, which in many cases overflows its margins and fills the space contained within the closed letter. Elsewhere a separate spray of scroll work fills the space. In every case it is (like the letters themselves) largely designed and vigorously drawn—as one might expect of this consummate "Little Master."

Much less interesting to me than Van Meckenen's letters are those initials, printed at Augsburg in 1483, in which the closed letters frame little pictures, quaintly conceived, but not eminently beautiful. It was a common practice to make the initial letter, where it was possible, enclose a picture; but it was obviously not always possible; and, where it was, it is doubtful if that makes the best frame. I think not. The picture frame idea is persistently carried out in an alphabet by Mathias Geron (1555). So absolutely are these regarded as frames, that the pictures are cut on little separate blocks let into the larger one: you can see where the picture is cut off square. Often the letter is sacrificed to the frame. This is most felt in the letters S in which the most emphatic part of the letter is eliminated to make room for the picture. In another alphabet of similar kind Geron has evidently felt that his initials did not speak for themselves, and has accordingly introduced a little explanatory letter so that there shall be no mistake about it. The little pictures were interchangeable. The same letter is used to frame separate pictures, and the same picture is framed by various letters.

The late Gothic letter of the more fantastic kind, penwork in excelsis, is effectively illustrated in the initials printed at Ingolstat in 1563, which are very characteristically German. There is too much flourishing of not very carefully considered lines in them, the kind of lines which would lend themselves to braiding; but they have character, they are broadly penned, and they are not too difficult to read.

On the other hand, the identity of the smaller letters (printed at Erfurt, 1527) is lost in flourishes. Many of them are quite unreadable. They show the writing master quite astray. Altogether saner German letters are those next shown. There is no mistaking there the broad sweeping lines which mean business: and they are freely and gracefully penned: the subsidiary flourishes are subsidiary: they keep their place, and merely furnish the space about the letter.

The influence of the goldsmith is to be traced, I think, in the initials of the elder Cranach—in which the outline of the letter is well nigh lost in arabesque. These letters might almost have been designed to be beaten in gold.

The design errs on the side of the grotesque, to which beauty is sacrificed; but it took a master to design like that; and the letters *are* designed. In the next alphabet shown they are merely decorated by intertwining scrolls, which to some extent confuse them.

The elaboration of those Roman letters by Cranach indicates the lingering of the Gothic spirit in the artist. The Roman letter was for the most part not much tampered with by the designer of the Renaissance. He accepted the orthodox form and emphasized the letter by ornament about it—just as we call attention to the commanding officer by putting gold lace on his coat, and, if he is very important, feathers in his hat. The idea is to distinguish the individual man or letter from the rank and file and to give him or it the dignity befitting the head of the column.

In the fairly well-shaped letters set in a framework of simple ornament—much the kind of thing that was done in damascening and niello—I am inclined to think that the character of the design comes from its having actually been cut in metal, not on wood.

In the Greek alphabet which follows the ornament does not go much further than a sort of scribble with the pen, just to relieve the plainness of the square panel enclosing the letter.

In the French initials the letters are again only in outline, relieved by a kind of niello pattern in black, which takes a square form though not enclosed in marginal lines. The breaking of the ground in that way gives importance to the letter, and in some cases makes it easier to read than it would have been merely an outline.

An English version of the same kind of thing is every way inferior to it. The thick line, to suggest shading on one side of the letters, is a vulgarism.

The French designs next shown are of a very different character. I say the designs because the letters are much the same kind of thing.*

One very obvious way of giving emphasis to an initial, is to show it in white on a black ground. That was quite commonly done. But, except on the very smallest scale, it was necessary to relieve the blackness of the ground by ornament in white upon it, if only to disguise any lack of solidity there might be in printing. And, of course, it was the simplest thing the engraver could do, to engrave filagree ornament in white line. (Here, by the way, we get an early 16th century instance of "white line" engraving which is claimed as the invention of Bewick. The ornamentists, at all events, were before him.) The background is frequently reduced from black to a dark grey tint by minute dots of white.

Many good Renaissance initials are blemished by a feeble indication of shading. But it is very plainly shown in other work of the same period that if it is desired to reduce the volume of the white in the letter, the way to do it is by a simple central line, which, though it may suggest that the letter is not flat but incised, does not pretend to give the effect of incision.

The feat of making black letters effective on a black ground is accomplished in the Greek alphabet shown, which is Venetian work. The black letters are in the first place outlined in white (even with a double line) and the ground is then diapered with white pattern, which reduces it practically to the value of tint.

In certain Roman letters (again Italian) we find the artist hesitating between two or three opinions. He has not made up his mind whether he will shade his letters or not (he is obviously least successful when he does). And he has not decided whether it is best to use figures or arabesque by way of accessory to the letter. To me he seems very much at his best in ornament.

Many ornamentists of the Renaissance were never so happy as when they were playing with little boys — "putti" as the Italians called them, a nondescript kind of boy, lending itself much better than *babies* would have done to the purposes of design. Whether on a white or a black ground, they form a rich background to the letter. The robust little men in the next alphabet have been ascribed (I don't know on what authority) to Dürer. They are the work of a strong man without too subtle a sense of beauty—which description would fit Dürer.

With regard to designs of this class, and to many others in which more distinct feeling for ornament is shown, I wish to point out that the design is not in the letter so much as in the background to it.

Some of the very best boy figures ever introduced into initial letters, are those ascribed to Holbein — and not unworthy of him. These little panels (they measure about 2 by 2 inches) are as large in treatment as a Greek coin, but this, again, is not to design initial letters, but to decorate the panels containing them. Just so in the Dance of Death which Holbein also adapted to alphabetic use. But why turn the designs to that use?—degrade them to it I might say? They are not the best imaginable background to the letters —and the subjects would have been better— Holbein himself has shown that they *were* better

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* Here followed some reference to individual alphabets which apart from the illustrations would not be intelligible.

—without being mixed up with initial letters. I maintain that such designs are not designs for initials at all—though, when it is Holbein who makes them, they may be something better!

To be decoratively right figures must be adapted very skilfully to the spaces about the letters. In 16th century work the artist usually took care to do that, even in picturing the Labours of Hercules, or Balaam and his ass, and so on.

In the letters of the succeeding centuries, where figures are introduced, you rather feel that Bacchus, Ceres, and the rest are trying to avoid the interference of the letter, or that, for example, it is only the attractions of Endymion which make the lady forget that her head is dangerously near the pointed serif of the E.

In the case of the other delicately engraved subjects you have the uncomfortable impression that the ill-shaped letters have been planted in front of them. They are art pictures spoilt.

A return to better things is shown in the alphabet by the late Godfrey Sykes: I don't say it is equal to the work of the little masters, but it shows at least that he went back to a source where there was inspiration left. Certainly we cannot afford to found ourselves upon a period when design appears to have run dry! We must go back to learn. That is my excuse for inflicting upon you so much ancient history.

Lecture IV.—Delivered May 24th, 1897.

LETTERING IN ORNAMENT.

My discourse has been, so far, on lettering, its design, its decoration, treatment—to-night I am going to speak more especially of its use and application, once its design is mastered. The question is, no longer of ornamental lettering, but of lettering in ornament. But first I have a word to say about the initial letter generally and its ornamental use.

The *raison d'être* of an initial letter is that it should mark a beginning. It may be desirable to mark that beginning more or less emphatically; and there is opportunity, and need, indeed, of considerable judgment on the part of writer or printer in proportioning this emphasis to the occasion. I can imagine a case in which two or three *series* of initials might be used, with varying emphasis, in the same pages—but it would tax the judgment of anyone so to use them.

Nothing is gained by devising a variety of names for what is after all practically the same thing. The distinction, for example, between "initials" and "versals" is *ecclesiologistical.* I use that ugly, made-up, word to express a made-up thing. For whether it is an initial (which begins), or a versal (to which the priest turns), is a matter of no account: in either case the letter is a sort of signal, or reminder. If a versal does not mark absolutely a beginning it indicates at least where the reader is to begin afresh. The initial heads the chapter, then, as the capital heads the sentence or the word. It all means emphasis.

William Morris, in the very beautiful title page to his "Story of the Glittering Plain," makes most effective use of what would commonly be called initial letters as capital letters, not, you will observe, honouring the initial "t" of the word "the" with so much as a plain capital, which, in fact, it does not deserve—for, though it happens to come first, it is relatively insignificant. The art of design is in putting things in their places, and giving them their right value. That is what William Morris did.

An initial need not, because it is meant to be emphatic, on that account be very big. In common speech we emphasise a word more effectually by pausing before it than by shouting it. And the idea of pause may well explain, and to some extent justify, a certain disregard of obvious legibility in the initial. In the initial, if anywhere, it is permitted to be fanciful; it makes a pause before reading. Ornament which elsewhere might be altogether superfluous is here of distinct use in calling attention to the letter: by the time you begin reading, the form of even a rather involved initial will probably have emerged plainly enough from its ornamental entanglement.

That, to my mind, is no excuse for the pictorial initial. A picture may be more beautiful than any letter, and it may answer just as well to mark a beginning. In that case, let us, if you like, have the picture instead of it; but don't let us disfigure it by clapping a letter in front of it!

There are obvious limits to the purely ornamental initial, but I think there is still scope for design of the purely ornamental kind from which designers were diverted as early as the 6th or 7th century by the attraction of torturing birds, beasts and fishes into shapes which might do duty for lettering: the interlacing capitals of the Anglo-Saxon scribes would have been more beautiful if they had not been always breaking-out into heads of nondescript creatures.

An initial letter attracts attention to itself (even though it be not very large) by its very weight and character. You cannot well overlook it. And there is no occasion, because the letter is put in by hand that it should gesticulate wildly at you, as it often did. Without saying that such a thing should never be done, I must own I am inclined to resent the initial that sprawls all over the margin of the page. The illuminators, I know, looked upon the margin of a book as their own, a field for their exploits; but, once accustomed to the margin, I can't bring myself to consent to its sacrifice even to the ornamentist. By all means let us have ornamental borders and the like, but let us plan them within the margin, which is the fitting, the only, the necessary frame to MS. and type alike. The justly famous Choirbooks at Siena are illuminated with a delicacy rare even in Italian MSS. The pictures are perfect miniatures, but they are miniatures rather out of place. A delicate little figure should not be framed by a disproportionate initial decorated with dolphins as big as the saint herself. The charm of the page shown is in the perfection of the work, both in the miniature and in the ornament; as a page it is by no means perfect; it is not a whole.

The illuminated initial naturally affords scope which printing does not. It may quite safely encroach upon smaller lettering—and it is the business of the illuminator to make it break the text pleasantly. Many of the mediæval initials are beautiful: the letters are enriched and glorified by ornament, which yet does not overstep the bounds of reticence; and the result is dignity.

A more serious danger than that of losing the letter in superfluous ornament is, lest it should be detached from the context. The larger the initial the more danger there is of that. You may separate the "D" in "Danger" so entirely from the word that it reads "anger." I remember my eye being once caught by the word "election" on a placard. It turned out to refer to "popular songs"—a "Selection" it should have read, but the "S" did not count as part of the word. That is a vice doubly vicious in the case of an advertisement.

Lettering is so bound up with the printing of books that these inevitably come in for a large share of consideration in discussing the subject.

The title page naturally assumes extreme importance.

You have there another of William Morris's strongly personal designs (we have lost William Morris, but his influence will live). In this title to Rossetti's poems, we have a bold Roman letter encircled by meandering ornament too delicate to interfere with it, merely greying the ground, as it were. And, observe, the border has the value of a deeper grey tint.

Yet more effective is the title to "The Book of Wisdom and Lies," in which the letters are in white on a black ground, filagreed over with delicate ornament, the stems of which interlace with them very happily. The initial T on the opposite page just sufficiently carries the black into that, and makes the double page one.

A yet more beautiful page of Morris's bears the title of the "Tale of King Beowulf," also in light letters upon dark; but here the border, bold and effective as it is, is merged in effect with the panel it encloses, and we get one mystery of richest ornament—out of which the words grow, as it were, into significance as you look.

Not only in the pages of books, but on their covers lettering forms often a valuable ornamental feature—sometimes a very important one.

In the Grolier binding shown it is not conspicuous; but it is enough; and it requires taste to do so little. Clearly the more exquisite the design of the "tooling," the more seriously it would be hurt by coarse or ill-considered lettering.

Lettering is in itself ornamental; a well-printed page, consistently set up in type of all one character, though it may be, as here, of various sizes, not *displayed* after the distracting fashion of the modern printer, nor disfigured by superfluous squiggles or ornament—a merely well-planned page, is a thing of beauty; but it wants planning with, that rarest of qualities, taste.

A mere inscription is yet more susceptible of decorative treatment, even though devoid of ornament. The deviation from the simplicity of the normal letter may be but slight, and the effect yet ornamental. Of the two modern inscriptions there, both, as it happens, designed by way of advertisement, the upper one (designed some 25 years ago or more) is excellent. It departs from orthodoxy, but not from moderation. The lower one (American) is rather affectedly up-to-date. The letters are all "kicking up behind and before." High kicking is the rage; but I think the advertiser takes too readily for granted our interest in what he has to say.

I don't see why the artist should not take, on occasion, all manner of liberties with the size of letters, but there should be a reason for it. It should be done for the purpose of emphasis, to fill the line more evenly, to make the letters compose better, and not for the sake of mere oddity.

I have no fault to find with the freaks of the 13th century scribe, whose handiwork I show you; but then he was not writing an advertisement, but inscribing at the head of his chapter, as a mere formality, words which might be "taken as read." Their use, in fact, was, as much as anything, ornamental.

The decorative value of a simple panel of lettering is conspicuously shown in the tomb of Mary of Burgundy, at Bruges. The inscription itself is beautiful and legible enough, for all the flourishing of the letters, which are fantastic only at the base, where they can afford to be playful, their work being done. Mere inscription occupies there the place of honour—and deserves it.

Lines of lettering play again an important part in the composition of Sir E. B. Jones's gesso panel, "Perseus and the Grææ." The deep band of Roman text occupies the vacant space above the figures without in the least disturbing its breadth. You feel it is just what was wanted there. It has the value of ornament without any of the attractiveness which might have injured the picture.

There is a reminder in this most modern work of the inscriptions, as old as Sennacherib, deliberately carved in broad horizontal belts of cuneiform characters right across the figures in the reliefs from Nineveh. It is strange how readily one accepts that kind of brutality. The truth is the writing does but little hurt to such broadly conventional figures, and it has considerable decorative value.

In early 16th century tapestries we sometimes find the name of a personage written straight across his body, not, as it were, emdroidered on the drapery, but planted boldly in front of it; and I, for one, accept that as perfectly satisfactory.

Another use for inscription is by way of border to the picture, as in the little terracotta shown, and on many a mediæval brass and monumental stone. It was a favourite practice in the 15th and 16th centuries, and never failed of success.

A very pronounced use of inscription was made to separate subject from subject in those little figure groups in which the mediæval designer delighted. The door from Le Puy, there, is designed in little square panels enclosed in bands of lettering, at least as important as the pictures it frames. It is all very flatly carved, not much more than grounded out. The contractions in the lettering make it difficult to decipher; but it proves to be Latin Hexameters (explanatory, of course, of the subjects) running right across the four divisions of the door.

It was a favourite plan of the glass painter also, to keep his pictures apart by interspaces of lettering.

In the jesse window, on the other hand, from Troyes, the inscribed words form part of the picture, and ornamentally a very valuable part; remove them and the design would suffer considerably. They give just the horizontal lines necessary to counteract the uprightness of the window mullions.

A much simpler use of lettering is shown in the glass from New College, Oxford, where the background to the figure is just sprinkled with crowned "M's." They are just enough to break the monotony of the ground, at the same time that they convey to you that this is indeed the Virgin Mary.

In coins lettering forms naturally an item in the design. We always arrange it round the rim. That is one way of doing it—but not the only one. The Greeks were never so wedded to one mechanical idea. They worked quite as often in columns, vertical or horizontal, and you see by the direction of the arrows there that the writing took all manner of directions—we are as conservative in that as in the way we pass the wine.

Again, the medallists of the Renaissance were not anything like so bigoted as we. Where the words follow the rim they are as likely as not interrupted, perhaps by a band of lettering across the medal; and the interruption is usually welcome. The proportion of the letters is, of course, an all-important point.

The modern designs of M. Roti shows taste and judgment in the introduction of lettering very rare indeed in 19th century design—and he too uses it in various ways, and not on one cut and dry system—as may be seen in the series of designs by him.

While the coins and medals are fresh in your minds I will show you some Italian majolica plaques in which also the design is planned to fit the circle. The first is a marriage plate. "My heart I bear to you" says the lady—And she does—proudly and uncompromisingly. A more decorative treatment is where the motto is inscribed on a label. Here it takes the line of the circle, and its curled up ends are made use of to furnish the space about the lady's shoulders. The circumscribing of the background by the label, passing behind the head, is a most useful device in composition. With the twisting of the label comes the question how the lettering upon it ought to run. It seems only logical to ask that it should be confined to one side of the label only. In that case care has to be taken lest part of it should be shown upside down. It is easier, as there, to ignore the difference between the front and back of the ribbon—I prefer more conscientiousness. You may assume, of course, that the label is first twisted and then inscribed. You must do so unless you are prepared to let great part of your inscription be lost; but, in any case, the label ought to be, and ought to look as it were, designed to take the lettering. In the example shown, all that ribbon was not wanted to bear one little word—it is flourished about, obviously, only to fill up.

The label on the Gubbio drug vase shows the origin of the idea: it is clear that it takes the place of the strip of parchment on which the name of the drug would else have been written.

Great use was made of the label in stained glass. It is often much more elaborate than in the lights exhibited from Ross; but there you have the typical treatment. The length to which inscription was carried in Gothic design is shown in a very curious carpet at South Kensington. You find there not only a double series of labels canopying the figures—but broad labels, parti-coloured, white and yellow, throughout their length. Moreover, the lettering is not uniformly coloured. Red words alternate with blue, for example, each with its white initial, all on a gold coloured ground. Sometimes the variation of colour is not according to the words at all, but as the artist listed.

In the border to a late Flemish brass, the label takes a meandering line, whilst in the side spaces are little figures bearing other inscribed labels. You see them at a disadvantage there—they appear to stand on their heads. The design was intended of course for a pavement brass.

Again, unusual is the device of two bands of lettering, interlacing to form a border, one of which always presents itself to the reader the wrong way about.

In the German needlework, parts of an altar cloth—a real linen cloth—not one of those gorgeous arrangements in velvet and gold, which seem to contradict the fundamental idea of the Lord's Supper—the bands of black letter steady the design and give variety.

Skilful but very reticent use of lettering is shown in a Portuguese cabinet at the Hotel Cluny. Inlaid at intervals round the edge of it are the words "Audeo," "Spero."

A very simple box-front illustrates the way a word may be so distributed by the carver as to be in a way disguised, and yet plainly there. You do not at first realise that the letters spell the name JAKELINE.

Much more elegantly designed letters occur in the box-top bearing the A of Anne of Brittany. The position of the letters on the box-top (a thing which has no right way up, but may be looked at from either side) justifies the reversing of the letter. As you see it there, you fancy the letters are A. V.

I come now to the subject of monograms.

Designers of monograms very often don't play fair—perhaps, because they don't know the rules of the game. A monogram, as its name implies, is the union in *one* sign or compound letter of all the letters of a word (usually a proper name) or of the several initials of a person's name; the mere interlacing of letters complete in themselves, and independent one of the other, forms, not a monogram, but only a cipher. In a monogram there should be no letter which does not also form part of *another*.

The common practice is to interlace two independent letters. And even these cyphers are eked out by ornament which is no part of them; and where that is not so, one of the letters is perhaps so extravagantly shaped as hardly to pass for what it represents. Very commonly one of them is unduly drawn out to make it loop with the other. Often letters of two quite different styles of design are incongruously harnessed together. Sometimes they don't properly interlace; one is just planted in front of the other. That may be permissible; but the other plan is preferable.

In monogram design, naturally, the letters you have to deal with, and your purpose, suggest the kind of letter you adopt; but the simpler are, as a rule, the more serviceable; the late Gothic capital form is about the least promising for a monogram—it is involved already.

You may think it hard lines to lay down the rule that each letter must form part of another, and no one of them be independent. Well, those are the rules of the game! You need not play it!

It may not be possible in every case to make a true monogram out of given letters; godfathers and godmothers, in our baptism, do not take into account the difficult task they may be providing for the designer, when they bestow their awkwardly assorted names upon us.

I have tried there what I could do with the letters of the alphabet three by three as they occur. I give you them as they came. No doubt they could be bettered—but that is the best I could do right off. You will see I have managed to make true monograms of most of them.

It was a common practice not only to interlace letters, but to reverse them—or one of them. By this turning over of the letters you get symmetry, but it is rather a cheap way of getting it.

In the severer cyphers on the Palissy plate, the C is reversed—the H also is sometimes doubled, without being merely turned over.

A masterpiece is the vigorous and individual design of Van Meckenen, in which he makes a mystery of his own name.

Hidden away in the beautiful little ceiling of a window bay, in the chamber of Isabella d'Este, at Mantua, are sundry cyphers and mottos—but the lettering is not of great importance in design.

In the embroidered cloth, on the other hand, the lettering is almost everything. And it shows how decorative even stiffly drawn devices may be. It only wants the artist, and he must feel that lettering is worth doing.

The cyphers on the key handles of the 17th and 18th centuries are not very clearly made out amidst the lines of scroll purposely designed to mingle with them. By means of the scrollery it would have been easy to balance the several compositions without doubling over the letters, as is usually done. But take them for what they are, those are elegantly designed.

Never perhaps was the cypher turned to more dignified use than in the ceiling of the Salle de Diane at Fontainebleau. We are apt to associate monograms and cyphers with something rather small and finnikin; but the breadth and dignity of that ceiling is unsurpassed.

Obviously it was not desired that the German letters next shown should be too easily read; they are embroidered in two colours so that the continuity of the latter is broken. In early Lombard and Saxon MSS. capitals were similarly parti-coloured. This is a device which may on occasion be of considerable value to the designer.

Gothic lettering makes nearly all the ornament in the 15th century lock, there. The shape of the letters owes something to the necessity of chiselling them in iron. The design is interesting; but the smith has carried his work to a point of delicacy at which it was bound to suffer with rough usage—as, you see, it has.

Of modern lettering I have only time to show you a single specimen—just to remind you of the many ingenious and beautiful things Walter Crane has done in that way. This is from his "Book of Marriage Days;" the stems of the dog rose grow into the word "June."

Most characteristic is the use of lettering in the Visigothic Crown, preserved at the Cluny. It is a votive crown, you will remember, not meant to be worn on the head, but to be hung up before a shrine. Hence the kind of fringe into which the letters are worked. It is barbaric perhaps; but the barbaric is often ornamental; and this is work of the 7th or 8th century. One seems to trace in it some oriental influence—or imagines it, perhaps, remembering the Moors in Spain.

The people who succeeded above all others in making really decorative use of lettering were the Arabs. The laws of the Prophet forbidding them to picture things, the natural desire to tell something in design, led to the profuse use of inscription; and, natural ingenuity and ornamental instinct aiding, they accomplished marvels. Very probably they took liberties with the written character which we should not be allowed to take. Possibly we find the Arab lettering all the more ornamental because we don't understand it, and the words, therefore, don't shout at us; but, anyway, the end of art is gained.

There are two forms of Arabic alphabet, the "cufic" and the "neskhi." The cufic is that stiff rectangular graven character shown in Alhambresque ornament which you only suspect to be lettering because it would be difficult otherwise to account for the rather odd form of ornament—for ornament it is.

Designers will note how in such work the letters are detached from the arabesque by the simple device of fretting the surface of the ornament, which, else, might compete with them. As it is, they keep their place.

The neskhi writing is the rounder and more elegant character, whose flowing, sweeping lines proclaim the pen. This is, in fact, the cursive hand, and has undergone considerable modification in various countries—as writing would.

The example on the screen is from some beautiful Damascus tiles—painted, of course, but retaining much of the pen character—(the letters are in white against a background of blue on blue).

Compare the "Cufic" character with the square form of the Chinese alphabet which, as I explained, was the monumental, as distinguished from the written character, which was brush work. I think the Chinese characters make ornament.

To return to the Arabs. Naturally they made most use of the suaver *neskhi* character. This is very freely treated in the plaque of Persian faïence; and there the character of the lettering tells pretty plainly the way it was done. That is clearly not carving; it is soft clay, or slip, which is applied to the face of the tile and fused with it in the furnace; then it is decorated in colour and lustre.

The wall diaper from Tunis is the kind of thing familiar to us in the Alhambra. The words are as it were built into an all-over pattern of great richness. The Moors in Spain make that kind of raised plaster work gorgeous with blue and red, and gold enough to reconcile even crude colours.

Time fails in which to carry further this most interesting subject. I will end by saying that if only we modern Europeans were allowed to play with letters, as the Arabs did, we might, with practice, arrive (even with our alphabet) at something like ornament.

That is the point to which all I have said is really directed, that artists should dare believe there are possibilities in lettering; it is only in that faith that art is possible.

Miscellaneous.

TOBACCO IN GERMANY.

The consumption of cigars is steadily increasing in Germany, whereas the use of the old clay or porcelain pipes is steadily decreasing. In the cigar manufactories of Baden alone 1,000 to 1,200 more workmen were engaged last year, and it is said at the same time that the goods stored in 1895 have also been disposed of; the demand at times was greater than the production. Through the increase of cigar factories, there is a growing stock of raw tobacco for pipes. But while the cigar is driving out the pipe of the German middle classes, the labourer and the peasant, on the other hand, an enemy is arising for the cigar in the cigarette and short pipe, the use of which has been imported into Germany from England. The Consul-General at Frankfort says that the German manufacturers of cigarettes look upon the constantly increasing use of foreign cigarettes in Germany with much uneasiness. The import, which in 1895 was only 44,900 kilogrammes (98,780 lbs), advanced to 161,800 kilogrammes (355,960 lbs.) in 1895, and 171,700 kilogrammes (377,740 lbs.) in the first eleven months of 1896. It surpasses the value of the German export of cigarettes already six times, and is at least half as large as the value of the cigarette manufacture in all Germany. France is sending large quantities of cigarettes each year, and the imports from Turkey, Greece, and Herzegovina are also increasing. It is stated that the importation of English smoking tobacco might be increased, and it is already slowly but steadily gaining ground. At Frankfort a great deal of English tobacco is smoked, especially by the upper classes. It is Consul Oppenheimer's opinion that English tobacco and pipe manufacturers might with advantage open business connections in many places in Germany. The wooden pipes which of late have almost entirely ousted clay and porcelain pipes, are indeed manufactured a great deal in Germany, but they are finished in England, especially the better qualities (silver mounted), and these find a ready market. Considerable attention has lately been given in Germany to innovations in the culture of tobacco. The tobacco plant has been known in Europe for three centuries, and during the same period its culture has been an annual one. The seed is sown in hot beds, brought to germination there, and when the young plants have grown somewhat, they are transplanted into open soil in order to be harvested when the valuable leaves have developed. This culture is based upon the idea that the tobacco is an annual plant and cannot outlive the winter, so that it must be sown annually, and be planted afresh every year. Now it is said that tobacco planters and botanists have been mistaken. Wilhelm Daróezi, of Budapest, the editor of a Hungarian tobacco journal, has proved that tobacco is a perennial plant, which may be kept in full vigour for years, and that it then has fresh leaves every year. Should these leaves in the second year and later on prove of use for smoking material, this discovery will bring about the possibility of saving the tedious and expensive method of growing seedlings every second year or oftener, and doing away with their planting in the open fields, and thereby of reducing the cost of production of tobacco very considerably. Whether this will be applicable also to the German climate cannot yet be asserted without trial. Two German tobacco manufacturers have also kept tobacco over winter as decorative plants, and one of them is even in possession of a plant aged seven years. Both are of opinion that these perennial plants only bring forth diminutive leaves, so that the value of plants kept over winter is but trifling, regarding them from the point of view of leaf tobacco. M, Daróeziis of a different opinion in this respect. According to his views these small leaves are only a consequence of the unfavourable climate, perhaps the fault was also with the kind of plant which had been chosen to stand over the winter; at all events he says that he obtained good useful leaves even in the second year's crop in Hungary. Though in this respect the importance of the discovery may be doubtful for the culture of tobacco, the observers are so far unanimous on one important point, viz., as to the possibility of increasing the tobacco by seedlings from perennial plants. This observation is of the greatest importance if it is possible by cutting the tobacco plant after the harvest to shield the roots against frost by covering them up, they will, at the beginning of spring, germinate again and furnish shoots which can be planted out. In this way it would be possible to shift the tobacco harvest in Germany into a more favourable season of the year. This may become of importance to the culture of tobacco in such a way that tobacco gathered and dried under more favourable temperature and conditions of humidity would probably be much better in quality than hitherto.

SCHOOLS OF AGRICULTURE IN ITALY.

Several agricultural schools have of late years sprung up in various parts of Italy, the most important in the Naples district, says Consul Neville-Rolfe, being that of Portici. The school has been in existence about 24 years, having been originally established by the province, but it was taken over by the State, and re-established by Royal Charter in 1885. A portion of the disused Royal Palace was given over to its use, the spacious grounds, gardens, and useful group of farm buildings being especially adapted to that purpose. The instruction is conducted by sixteen professors, each of whom takes his own branch of the subject, as chemistry, botany, horticulture, zoology, entomology, geology, farm accounts, meteorology, physics, forestry, irrigation, &c., and lectures upon it. The course occupies three years, after which students who satisfy the examiners obtain the degree of *Laureato Agronomo*, or bachelor of agriculture. Besides the lectures, practical instruction is given in the field, and the making of cheese, wine, and oil is systematically carried on. It is, in short, an agricultural university; 670 scholars have passed through the school, of whom 228 have obtained degrees, and there are 21 freshmen inscribed for the coming year. Most of the laureates become professors in other colleges in Italy, and some have gone to other places, such as Cairo, Buenos Ayres, and San Francisco. One very useful branch of the institution is the exhibition of agricultural machinery, upon which the future of Italian husbandry depends so much, and another, the dissemination of pamphlets by the various professors on their special subjects. Of these last there is a very interesting one by Professor Italo Giglioli, the head of the school, on the importation of Italian fruit into Great Britain. He begins by stating that the total importation of fruit into the British Isles has risen from £5,977,351, in 1880, to £7,287,566, in 1890, with a steady annual increase. Besides this, in 1890, nuts to the value of £622,936 were imported. In 1890, only 4 per cent. of the fruit imported into Great Britain came from her own colonies, and 8 per cent. from Italy, but the Professor is strongly of opinion that while the colonies have increased their export to a very large extent, the next decennial period will show that Italy has not been idle, and that with more attention to cultivation, packing, and means of transport, the Italian fruit will obtain a more influential place in Great Britain, which is shown to be the most influential fruit market in the world.

Notes on Books.

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OUR COAL RESOURCES AT THE CLOSE OF THE NINETEENTH CENTURY. By Edward Hull, F.R.S. London: Spon. 1897.

The Royal Commission which reported a little more than twenty-five years ago, on the amount of our probable coal supplies, to a large extent reassured those whose fears had been excited by the works of Professor Stanley Jevons and of Professor Hull himself. The Commission practically reported that at the then rate of output there was more than enough coal to last for another thousand years. Of course this estimate was —it could not be otherwise—highly speculative. The depth to which coal can be worked was, and is, a matter of opinion, certainly the limit has not yet been reached even with present appliances. The chance of our supplies being increased by new fields in Kent and elsewhere in southern England is at all events an important item. The sizes of the seams which can profitably be worked, and which should therefore be included in the estimate, is a question on which authorities differ. Finally, the rate at which the demand will increase cannot be satisfactorily calculated. Nevertheless it seems possible to estimate, within very wide limits, the duratton of our coal supplies. As above said the Commission put it at over a thousand years. Dr. Hull, allowing for a doubled output, and on his amended calculations, gives four hundred years.

Dr. Hull gives in this work—which may be considered as supplementary to his "Coalfields of Great Britain"—careful and elaborate statistics of all our different coalfields. The total amount of coal available by the end of the century he puts at 58,275,700,000 tons in the visible British coalfields, 23,253,000,000 in the concealed areas, and 155,300,000 in Ireland, making a total of 81,683,000,000 tons. The annual output is now over 195,000,000, so that with a very slight annual increase the above amount would be exhausted in about 400 years.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The Report of the Proceedings of the International Congress on Technical Education, held at the Society of Arts in June last, has now been published—price 3s. 6d., by post 3s. 10d., and can be obtained on application to the Secretary, Society of Arts, John-street, Adelphi, London, W.C. The volume consists of 307 pages, and contains a report of all the papers read and the discussions, with appendixes giving lists of officials, delegates, and others taking part in the Congress.

Proceedings of the Society.

CANTOR LECTURES.

MATERIAL AND DESIGN IN POTTERY.

By William Burton, F.C.S.

Lecture I.—Delivered January 18, 1897.

Of all the crafts practised by man that of the potter is among the most ancient and the most universal. For spinning or weaving, for working in metals, in wood, or in bone, some intricate or troublesome preparation of natural material is required; but the prime material of the potter—clay—lies ready to hand in almost every region of the earth's surface, needing so little preparation to fit it for use, and so readily manifesting its power of taking and retaining the shape of any object squeezed into it, that we may almost say: "Clay created the potter." As to the invention of pottery, that need not delay us a moment; a device so obvious as the making of the simplest form of pottery is within the scope of a child, given the material; and every tribe, or race of men inhabiting a district where clay was to be found would as naturally become potters, as the dwellers by lake or stream became fishermen, or people living by the sea became navigators. All the primitive races of ancient or modern times, from the earliest peoples of Egypt, or the neolithic races of Europe and America, to the present-day South Sea islander, or African Kaffir, have not only practised the potter's craft, but have practiced it in the same rude and elementary way. A glance at the collections of primitive pottery in any good museum will reveal the whole extent of such a potter's craft. Vessels of rude but not unpleasing shape scooped out from a ball of clay, or patiently built up piece by piece as some birds build their nests; softened into shape by pliant fingers or simplest tools and then hardened by prolonged drying in the sun; such is, in brief, the potter's craft in its simplest form—the starting point from which all the world's work in clay has grown.

When we think of the works that have been wrought in clay—of the brick building of the Chaldeans and the Romans, the delicate terra-cotta work of the Greeks, the glorious painted tile work of the Persians, the rich and glowing majolica of the Italians, or that most *recherché* product, the porcelain of the Chinese—it seems incredible that these should all have sprung from such rude beginnings. Yet careful study forces us to the conclusion that each of these peoples started from the primitive foundations just described, and, by a succession of steps which can in many cases be clearly traced, gradually evolved that natural form of pottery which has ultimately become one of their most distinctive possessions. To trace these in detail would be entirely out of the question, the subject is so vast and intricate; but it may be possible within the limits of your time and patience—worthy also of your hearing and my saying—to trace, as clearly as may be the part which the material itself has played in these great changes. A part at once more subtle and more profound than could be, imagined by anyone who had not devoted years of labour to the practical side of the potter's craft.

As a simple yet striking instance of this influence of the material, compare one of those small Greek terra-cotta statuettes, found in such large quantities at Tanagra and elsewhere, with the little figures of apostles and kings used to decorate the German stoneware jugs of the 16th century. As work in clay the contrast is striking and profound, and doubtless the first feeling is that these things epitomise perfectly the contrasting qualities of Greek and Gothic art. The little Tanagra figure, full of the Greek spirit, with its sense of grace, largeness, freedom, and rhythm; the German figures expressing not less clearly the rigour, hardness, and stolidity of the Teutonic mind. Sound and interesting as such a view undoubtedly is, we must not lose sight of the fact that if the final result be in harmony with the art of the maker, it is not less completely in harmony with the qualities of the material. Even the Greek hand could not have produced work of such grace and lightness with the stiff, unresponsive material and method of the stoneware maker; nor the German, work of such mail-clad hardness in the terra-cotta clay, which was so responsive to the slighest manipulative touch. Both these pieces were moulded, but in one case from a mould formed on a clay model, in the other case from a mould carved in a slab of alabaster or of limestone, and it needs no label to distinguish one method from the other. (Figs. 1 and 2.)

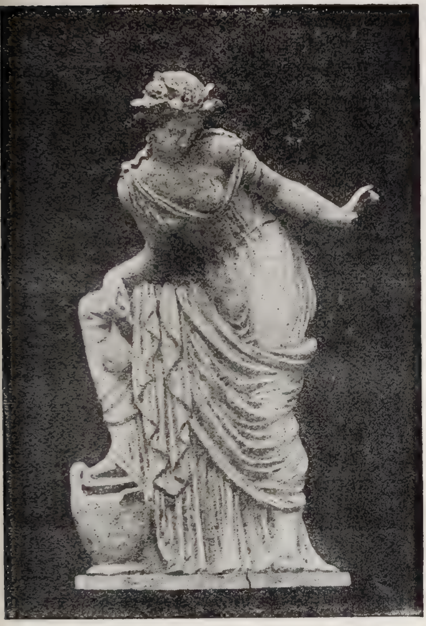
While therefore all potters have worked in clay, the clays themselves have possessed such different qualities of working, and have behaved so differently under the action of fire that the potter has never been able entirely to do what he *would*, but must perforce content himself with doing what he *could*. The potter, in common with every other craftsman, has frequently made the mistake of trying to push his work beyond the powers of his material, yet, that work in pottery, as in other things, will remain most interesting in which the workman has *felt* his material, and, following the teaching of the material and the hints of the tool, has been content to do those things which were well within the united powers of all three.

What then are the characteristic qualities common to all varieties of clay which determine the fabrication of the simplest pot. Shortly, these qualities are two only. First, the property of being kneadable when moist into almost any required shape (what we term plasticity), and, secondly, the property of becoming dense, hard, and durable when fired. These two qualities are possessed by different clays in very varying degree, and from these variations have sprung the broad distinctions between the different forms of pottery, so that when we speak of earthenware, stoneware, or porcelain, we are merely distinguishing between different varieties of pottery which have resulted from an extension by artificial means of variations already presented by certain natural clays. Thus, certain natural clays when fired produce a pottery which is porous and of no great hardness, while other clays fired at the same temperature would produce a form of pottery harder than the foregoing, and practically impervious to water. This is the broad general distinction between earthenware and stoneware, and the practical potter has simply succeeded in widening the difference between these products of unassisted nature until he reaches forms as completely removed from each other as an earthenware dinner plate and a salt-glazed drain pipe.

To turn now definitely to the main purpose of this present lecture, we have to consider what has been done with simple clays; that is, native clays used with but little preparation or admixture. All the world over, pottery is prepared from the clays found in almost every country, by the simple methods of shaping by the hand, or of pressing in a mould, or on to some natural object, such as a gourd. The early invention of the potter's wheel marked a great advance in technics, and enabled the potter to readily produce his forms with a greater degree of accuracy, and a finer, and more subtle finish. This possibility of finer finish by the use of the wheel soon led to greater care and nicety in the preparation of the clay. A common clay, dug as it occurs, and prepared into masses by hand, is only fit for common work, and until such clay is carefully improved by washing and decanting, and prepared into a smooth plastic mass by much beating with the hands and feet, fine work is impossible with it. This improvement is the first evidence of the general law that no advance has been made in the technique of the potter's art until it has been called forth by some extra refinement in the material, or by some improvement in the tools. Clay such as is used by the primitive potters is quite suitable for their rude or simple decoration of incised lines or applied drops of slip, but it would be far from suitable for such refinement of form as we find embodied in the Greek vases; neither would its surface be such as would display to advantage the simple, but dexterous, painting with which those vases were enriched.

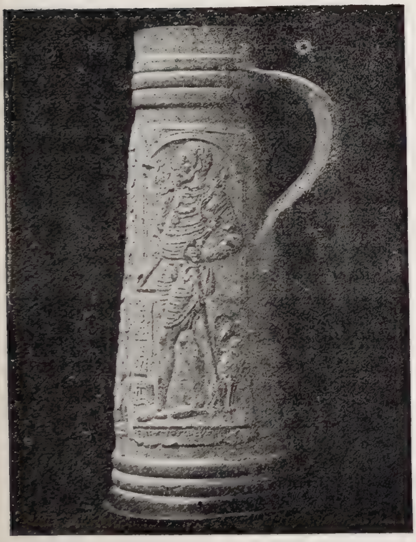
The main point with which we are concerned, however, is not so much the fabrication of the pottery, which, in the case of the simple earthenwares, is always straightforward enough, but rather the different methods which

Fig. 1.



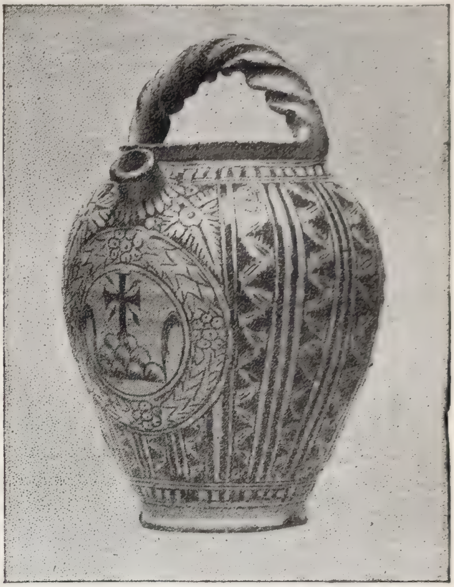
Terra-cotta Figure from Tanagra.

Fig. 2.



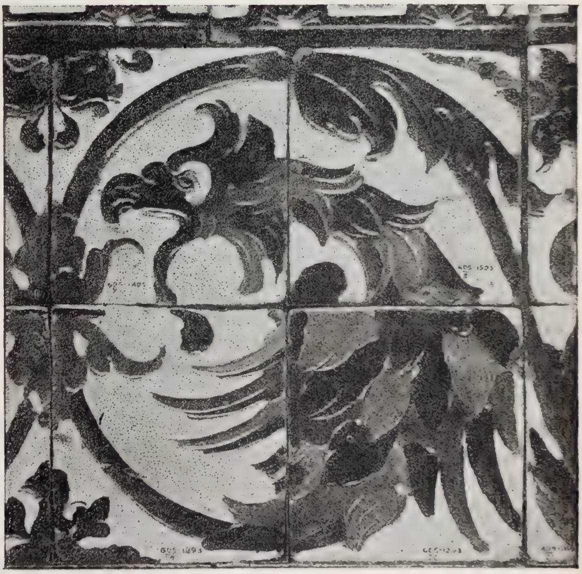
German Stoneware Ju .

Fig. 3.



Sgraffito Work.

Fig. 4.



Hispano-Moresque Tile.

have been used from time to time in various places for decorating such pottery. The early methods of decoration may be grouped under the heads of modelling, carving, incising, and inlaying, and in no case do they imply the use of any other decorative material than clay itself. The uses of clay for modelling or for carving are at once so natural to the potter, and so apparent in their results to anyone examining the potter's work, that we need do no more than mention them; but the other methods of using clay, at once so ingenious and so natural, yet capable of such great variety in their application, are deserving of more extended notice.

Incising has always been a favourite device of the potter, and the effects produced by its means are so readily varied according to the state of the work when this decoration is done, that even with unglazed wares its application is an eminently suitable one. If the vessel be incised soon after making and while the clay is yet in its soft condition, bold broad effects are readily produced with a simple tool of bone or wood, while if the vessel is allowed to dry or harden before being incised, then a sharper tool must be used, and the result is really a kind of engraving. In the one case we get all the softness and flatness of modelled work; in the other, the sharpness and something of the wiriness of engraving in metal, and it is always instructive to observe how the design will be modified in these cases to suit the exigencies of the material.

A further valuable extension is given to this method when the vessel can be afterwards glazed, as in this case the glaze will of itself, during the firing, flow down into the incisions and being of greater depth there than on the general face of the piece, will make the pattern tell with greater force as dark upon a light ground. Probably every nation has used this device, but never is it of greater use than when the resources of the potter are limited to the production of a simple green or brown glaze upon a light buff or red-coloured clay, and the Indian and Persian pottery decorated in this simple fashion is indeed admirable.

The decorative method known as *sgraffito*, and largely used by the potters of the Italian and Iberian peninsulas, is but an extension of this method of incising, reinforced by the use of two, coloured clays. In the most general way a vessel is shaped from a red clay, not far removed from brick earth, and then while the clay vessel is still moist it is dipped in slip (*i.e.*, a creamy liquid of clay held in suspension in water) of another colour, generally white or buff. The vessel having been coated with this slip, is then allowed to dry, producing a vessel of which the main substance is clay of one colour, with an outer skin of a differently-coloured clay. When such a vessel is incised and the incision is carried down through this outer skin, it of course exposes the real body of the vessel, and after firing the pattern shows in the colour of the inner layer, whatever that may be, against a ground colour of the outer layer of clay. The vessel marked 869—'91 in South Kensington Museum (Fig. 3, p. 1129), is a good example of this kind of work. We have already mentioned the tendency of the line incised in hard clay to look thin and wiry, and it is worthy of observation how this tendency has been largely remedied in sgraffito work by making the design usually tell as dark against a light ground, which must obviously give a richer and fuller line than if it were arranged to tell as light lines on a dark ground.

Closely connected again in method is the process of *inlaying*, by which a design of greater breadth can be produced in variously-coloured clays. This method has been extensively used both in our own times and in the middle ages for the production of the foolishly-named encaustic tiles, used so largely for the pavements of churches and other public buildings. In this case a simple design is obtained in intaglio in a cake of clay either by actually incising the piece, or by stamping it with a mould of wood or of plaster having the design in relief. Into the depressions produced in either of these ways a thick pasty slip of a differently coloured clay is poured, and when this slip has become sufficiently stiff by evaporation of the water to bear treatment, the entire surface of the tile is scraped flat, when the design stands sharply out, distinguished by the difference in colour of the ornament and the ground, which difference is, of course, intensified by the subsequent firing. Quite apart from the extensive use of this method for the production of decorated tiles for pavements, it is interesting to note the recent applications of this old process in various modified forms for very broad and simple effects in tiling for walls and other general surface decoration.

There is another style of tile decoration which always seem to me to have caught the hint of its method from this process of encaustic tile making. I mean those well-known Hispano-Moresque tiles, in which the pattern is produced by lines and patches of coloured glazes and enamels contained in cells sunk into the clay. In this case the design might have been sunk into the soft clay, either by actual incision or by stamping, and instead of filling up the cells with coloured clay, they were filled with coloured glaze. There can be little doubt of the close connection between the two processes. The ordinary glazed encaustic tiles of the northern monastery, produced by workmen who knew nothing of coloured glazes, would readily pass over into the other form when it came into the hands of potters who knew so much about coloured glazes and enamels as the Moriscos. The general relationship of the two methods is evident when one of these richly coloured designs is reduced to black and white, as in Fig. 4, p. 1129, which is taken from 605—1893, South Kensington Museum. There is a possibility that the hint of both these processes may have been taken from the process of Champlevé enamel, which appears to be older than either of them.

Worthy of mention as the most elaborate and intricate work in inlaid clays is the famous Oiron ware, the romance of which was so adequately set forth for us by Mons. Benjamin Fillon. In this ware, the light cream coloured clay of which the vessels were shaped was impressed with bookbinders' tools, and other tools fashioned on the same principle. The sunk cells thus produced were filled in with clay of other colours, generally red or dark brown, and after bringing the whole to a level surface, the ware was fired and afterwards glazed. The work itself was, from a technical point of view, marvellous in its neatness, precision, patience, and finish, but, artistically, it was of no great value; indeed, the despised process of printing on pottery is capable of producing better results on the same lines, particularly in the hands of Messrs. Minton, with infinitely less labour and cost.

We have already seen how the different colours assumed by different samples of natural clay on firing was taken advantage of in the foregoing processes of decoration; but the tints of fired clays furnish such a perfect scheme of gradation from white, through yellow, and bright red, to a chocolate so deep as to be almost black, that finely ground and washed clay has from a very early period been used to give a scheme of colour decoration, which from every point of view is pre-eminently suitable for pottery decoration. The perfection of decorative colour possible in even such a simple and limited range as this, is exemplified in the most striking manner by the Greek painted vases produced in such quantities during the centuries immediately preceding the Christian era, in nearly all the countries adjoining the eastern seaboard of the Mediterranean. This work, produced entirely by the use of coloured clays and of a lustrous black pigment of uncertain composition, manifests such graceful simplicity, and entire rightness of method, that within the limits of such a method, it must remain as the high water mark of achievement.

Other nations of ruder fibre have taken advantage of the varying colours of fired clays to produce a simpler and more vigorous style of decoration. When clay is worked up with water into slip of a creamy consistency, it can readily be painted on to unfired vessels in such a way as to retain a certain amount of relief and solidity, working in fact very much like "Gesso," and producing low relief with a nicely rounded surface, retaining the form given to it by the way which it leaves the brush. This slip-painting, as it is called, though in latter days done with a brush, was formerly done in quite a different way. The clay made into slip was contained in a small earthenware vessel having several fine orifices; into some of these, quills of various size could be fitted and then the slip was carefully trailed out through the quill tube, in lines of varying thickness, or in dots or spots, on to the surface of the unfired pot. Owing to the stiffness of the slip, the lines and dots thus produced have the characteristic roundness already described, and the similarity of effect produced in the Roman slip ware and the so-called Toft ware of our own country, is the result of similarity if not absolute identity of process.

How far it is possible to travel beyond the simple slip-painting here described is shown by M. Solon's work in the process known as *pâte sur pâte*, which is the glory and the pride of all work in slip. Here the clays have been refined to the utmost, enriched by fusible materials, delicately or strongly tinted by the addition of artificial colouring matters, and then finally glazed with a rich glaze, which develops at once and softens into something of mystery the translucence and the colour of the material—all this, used with deep insight and sympathetic skill, gives us a result as far removed from the humble slip-painting on which it is all based, as a Greek goddess is from an Indian totem.

Miscellaneous.

STRAW PLAITING IN GERMANY.

Straw plaiting was first introduced into Saxony from Austria, or rather from the then Italian provinces of the Austrian Empire. First settling in the northern parts of Bohemia, this industry gradually made its way into Saxony. Here, in the vicinity of Altenberg and Geysing, it developed into such importance that its products are now claimed to equal in quality those of Switzerland and Italy. The Saxon straw-plaiting industry affords an illustration of the importance of trade schools, and their influence on the industries. In introducing in the forties this industry into Northern Bohemia, one of the first acts of the committee for the advancement of the home industries among the inhabitants of the ore mountains was to establish straw-plaiting schools at Hochstadt and Zinwald. The influence of these schools was soon felt in the whole section. People began to cultivate properly the wheat and rye necessary for the straw, and to give the latter a rational treatment; they learned to classify the different grades of straw, to plait, and everything else pertaining to their new trade. The production of first-class plaits increased rapidly. In short, this industry established itself firmly at these places during a number of years, but for some reason the people failed to encourage their schools, the latter went out of existence after some ten years, and after another decennium little was left of the once flourishing industry. The United States Consul at Annaberg says, that during its best period this industry had spread across the border into Saxony. When it began to decline the authorities of the Saxon towns of Altenberg, Geysing, and Dippoldiswalde, recognising the cause, took up what their neighbours had neglected. Each established a school for straw plaiting equal to those which had formerly existed in Hochstadt and Zinnwald on the Bohemian side. The effect was surprising, and the schools turned out year after year raw recruits who were familiar with the art of plaiting and the materials employed. Their influence was not only felt on the Saxon side, but owing to the energetic support of the bodies interested, soon began to exercise a reviving influence on the dying industry in Bohemia. The latter, however, has never again attained that prosperity which it enjoyed when it had the stimulus of the schools at Hochstadt and Zinnwald. To-day the centre of the industry is on the Saxon side.

The material used for plaiting is chiefly straw and bast. The raw material for straw plaiting proper is ordinary wheat straw, and in Saxony as well as in Bohemia great weight is laid by those interested in the business on the production of suitable straw. The straw reaches the plaiter's hands in an almost natural state. The preliminary process it undergoes before becoming a plaited band or piece of openwork is a very simple one. A straw or section of straw is drawn between a piece of leather about the size of a boot-heel and a curved knife, so that it is flattened and straightened at the same time. It is then split into several strips by being passed once more between the piece of leather and a small steel plate with several teeth. The straw is used either in its natural colour or bleached in sulphur fumes by the workmen, according to the nature of the work in hand. Dyed straw is also made use of, but this is furnished by the dealers, as the ordinary workmen is unfamiliar with the dyeing process. Special treatment with chlorides, &c., such as the straw undergoes in other centres of the straw-plaiting industry, is unknown, The finishing process, such as washing and polishing the plaits, removing defects, &c., is carried out by the manufacturers of straw hats and similar goods. The second material used for plaiting in the Erzgebirge is bast, or more properly speaking, chips or wood shavings. These are extremely thin strips, from one-eighth to one-quarter of an inch wide, chiefly prepared from aspen wood, which is imported from Russia. This bast is used for the manufacture of so-called sparterie goods. It requires no further preparation before being used for plaiting. The plaiting itself is a very simple process, depending practically on the deftness of the hand, which is the only tool, so to speak, called into use. At present, bast is the principal material used in the production of so-called fancy goods. Straw, either in its natural state or dyed, is only used to ornament the bast-work body of the article with a kind of lace-like edging, for which purpose threads of silk, cotton, or horsehair are also used. With the simple preparation of the straw already alluded to, and the actual plaiting of the straw or bast, the share taken by the workmen of the Erzgebirge in this industry ends. The further transformation of the plaits into articles of trade, such as sewing them together to make hats, &c., does not take place there.

The straw plaiters proper—the inabitants of the cottages in the Erzgebirge—have no general knowledge of the trade by which they live, they are simply cottage workers, and the management of the whole industry lies in the hands of the dealers, who, in their turn, perform their share of the business in an exceedingly primitive way. There are two kinds of dealers, the small middlemen or factors, and the dealers or wholesalers. In some villages it is the innkeeper or the shopkeeper who acts as middleman; in other places this *rôle* is played by itinerant buyers of restricted means, who often start with a capital of not more than £1 or £1 10s. They wander from house to house, buying the goods in small quantities, and then disposing of their acquired stock to larger dealers. The small middlemen not only buy the result of the cottage workman's labour, but supply him also with the raw material, of which they keep a small stock in hand, as well as with the new patterns which fashion demands, and according to which the goods are to be made. The other class of dealers is formed by the export merchants, residing chiefly in Geysing and Altenberg. At the beginning of a season they go into the Saxon and Bohemian villages, taking with them the patterns procured in Dresden and Paris, and leave their orders with the middlemen or factors. The number of persons engaged in the straw-plaiting industry on the Saxon and Bohemian sides, may be safely estimated at 20,000 to 30,000, of which the females furnish the largest contingent. These are engaged in the work, almost without exception, from childhood to old age. The men are partly occupied in ore mining, but generally take up plaiting during the busy season, and at times when there is no work in the mines. The chief plaiting season is between the second half of October and Christmas, which corresponds with the condition of the trade in plaited goods, as the orders for America have to be ready for delivery by Christmas. Then the workers come together in groups, and, with a view to economise fuel, work sometimes in one dwelling, sometimes in another, meeting in the so-called *Rockenstube* (spinning-room), and there they plait industriously from early dawn until late at night, often, indeed, until midnight, or even till 2 a.m.; also after Christmas, as long as the rough winter lasts, even until April, the plaiting work goes on. In fact, plaiting is never entirely suspended, for even in the summer months, a plaiter makes up daily at least a piece in order to provide for pressing needs.

The earnings from straw plaiting vary much according to the season. They are highest in the winter months, notably in November and December, and lowest during the summer months. Moreover, variations in the pay are perceptible in different villages, and even in the same village for the same class of plaiting. As a rule, the larger dealers content themselves with a small profit of one farthing per piece, whereas the middlemen try to clear a larger proportion in return for their intervention — from three farthings to five farthings per piece. Plaiting is paid for according to the piece. The so-called "mandel" or shock serves as a unit. This is for straw plaiting, a strip of a little over 13 yards, and for chip plaiting, a band or border of 26 yards, which is wrapped up in about half-yard lengths. The prices per shock also vary according to the nature of the plaiting. The samples serve as gauges, *i.e.*, the so-called "twists" or "snaps" which form the side edges are taken into account, as are likewise the number of straws used (seven or eleven), and the use of a single or double straw. For an article for which there is a fairly good demand—say an article such as is produced in Zinnwald, a four-snap fancy work (chip plaitings)—the workwoman receives from 6d. to 7d. per shock in the principal season, but inasmuch as she must use about one pennyworth of bast for such plait, which costs about 4½d. per lb., she only realises from 5d. to 6d. for her labour. The price for the same goods sinks rapidly after Christmas, and about April the same article will bring in about 5d. at the most. The time required by a skilled woman worker to make such a shock is from three to three hours and a half. Two-snap chip work, which is somewhat simpler and more quickly made, and for which about three farthings worth of bast is needed, brings from 4d. to 4½d. about Christmas time. As regards the markets for the ware, in Austria very little of the plaiting is used, and only a few Vienna and Prague factories work up the German braids. Most of them are bought by the dealers on the Saxon side, and find their way partly into factories in and near Dresden; the bulk, however, goes to England and the United States. The whole of the plaiting industry is to a certain extent dependent on fashion, which has of late more or less turned away from straw to chip plaits, so that the latter form, for the present, the chief article made by the ore mountain plaiters.

THE CUBAN SUGAR INDUSTRY.

Cuba, in normal times, may be said to be one of the most favoured countries of the world for the economical production of sugar. The present condition of affairs greatly burdens the sugar industry, owing to the necessity of protecting the estates, the loss of cane through incendiary fires, and the difficulty at all times of getting enough hauled to the works to use them to their full capacity. The methods of manufacture in Cuban sugar houses are good as regards the kind of machinery used. Immense sums have been spent in the last ten years in this direction. The mills, evaporators, vacuum pans, and centrifugals are usually of the best description, but the general internal management of the sugar houses leaves much to be desired, except in a few instances. A good deal of sugar is lost by crude methods, and in very few places is there exercised that chemical control which has brought the best of sugar houses to their present state of perfection. The British Vice-Consul at Havana, says that considerable advances will doubtless be made in time in the control of the sugar houses and the growing of the cane, and with good administration it is likely that Cuba will soon again become the largest cane-sugar producing country in the world. Under normal conditions, the contrast between the Cuban industry and that of the West Indian Islands, or any American sugar-producing country, is remarkable. The total sugar crop of any other island is equal only to the output of three or four of the largest Cuban manufactories, and, with the exception of Demerara, all these countries show considerable inferiority to Cuba in methods of manufacture, and in the class of machinery used. Of the other cane-sugar countries of the world, Java is the only one which comes within 50 per cent. of the amount of sugar produced annually in Cuba in normal times, and Java and the Hawaiian Islands are the only ones which are generally advanced in the process of manufucture. Until a very recent date, the manufacture of sugar and the growing of the cane in Cuba were extremely profitable undertakings, and the reasons for their prosperity may be stated as: (1.) The excellence of the climate and the fertility of the soil; the rainfall about 50 inches is so distributed that irrigation is not a necessity, though in some cases it would be advisable. (2.) The great movement towards the centralisation of the estates which took place in the early eighties; planters having understood the value of large sugar houses, and overcome their difficulties in this way. (3.) The proximity of the United States affording as it does a cash market for the sugar. It is a matter of surprise to many with experience in other sugar-producing countries, that even with the above advantages the Cuban sugar crop should have reached the great amount of 1,000,000 tons, for, while elsewhere the sugar industry is fostered by bounties, as in Europe and the United States, or by special treaty with the country where sugar is sold, as in the Hawaiian Islands, in Cuba the growth of production is hindered by direct taxation, and by very high duties on the various necessaries of manufacture. Besides this, the want of ordinary roads and bridges is severely felt at times. Further, the freight charged on railroads and coasting steamers is excessively high. The Cuban grinding season lasts from about December 1st until the spring rains begin about May 15th. During this time very little rain falls, and the crop may be harvested without damaging the roots of the cane—a very important consideration where land will continue to yield well for from 8 to 25 years without replanting. The crops vary from 40,000 to 120,000 *arrobas* per *caballeria*, that is, from 12 to 50 tons per acre, and the cane contains from 13 per cent. sugar in December, up to 18 per cent. in March and April. The manufacturer's aim is, therefore, to begin as late as possible in order to profit by the refining of the cane. Very little manuring has been tried yet, and in a few places only is there any well conducted cleaning of the fields in the dead season, or proper ploughing before planting. Old wooden ploughs prevail in many districts. No irrigation works of any account exist, and no trials of any scientific value have yet been made to determine the kind of cane best suited to the soil and climate; in fact, the natural agricultural advantages of the country have been relied upon up to the present, and have been found sufficient to ensure large profits. Most of the cane is transported to the sugar houses by narrow-gauge roads built for this purpose, which are often from 10 to 40 miles in extent, and connected with the main lines. Transport by canal is not known. In respect to daily capacity, the Cuban sugar houses are in advance of those in any other country. Very many can grind 1,000 tons of cane in 24 hours, and some can do more than this. There are in France and Belgium, known as *Usines Centrales*, where the juice is conveyed by a system of pipes from small juice stations to a central establishment, which equal or excel the Cuban houses in capacity, but elsewhere there are none so large. As was expected, the sugar crop for 1896 has been a very small one, even as compared with the output for the previous year. The total production of sugar in 1896 amounted to 225,221 tons, as against 1,004,264 tons in 1895, thus showing a deficit of 779,054 tons, or 77·5 per cent.

THE LACE INDUSTRY OF CALAIS.

During the past twenty years Calais manufacturers have overcome all opposition, and have made that place the most important centre of lace production in the world, especially for silk- and fine cotton-laces, which are made in an immense variety of design and perfection of workmanship. The finish of Calais lace is, says the United States Consul at that port, admittedly better than that of rival manufacturers in other countries, and this superiority is due to the fact that the manufacturers themselves exercise extra care and supervision over their goods before they leave the factory. There is hardly any kind of real lace, enjoying various national or world-wide reputation, which at one time or another has not been perfectly imitated by the highest grade of artistic draughtsmen, and reproduced on the lace machines of Calais. Scarcely a year has passed which has not recorded some remarkable progress in design and fineness of execution, and at such a reduction of cost that millions of consumers are now enjoying the benefits in place of the comparatively few who could afford to buy the hand-made article. The laces now being produced by the Calais manufacturers are comprised in the following lists:—

Silk Laces.—Chantilly laces for millinery purposes, mantles, dresses, &c.; guipure laces, Bourdon laces, Spanish laces, Valenciennes laces, Chantilly and guipure mixed laces, silk application laces, imitation Plauen laces, Irish point laces, beading laces, button-hole laces, narrow silk edgings and insertions.

Cotton Laces.—Valenciennes, Maltese, Alençon, Bourdon, imitation Plauen, Platt Valenciennes, Migniadise, Madeira, Venise, Luxeuil, Irish point; button-hole laces, beading laces, *point d'esprit* laces, *point à l'Aiguille*, duchesse, moresque; Cluny edgings and insertions, and Honiton braids.

Silk and Cotton Mixed Laces.—Fedora, Bourdon, *point à l'Aiguille*, duchesse, Venise, Malines, moresque, Alençon, Madeira; Honiton braids.

Veilings.—Veilings with "Russian" ground, veilings with *friquette*, *bouclet*, and plain grounds; Brussels net, bordered net, also nets with small figured patterns or spots (all the foregoing are made in all silk and also silk and cotton mixed); chenille nets, all silk.

Dress Nets.—Chantilly nets, made in all silk or silk and cotton mixed; Malines nets, made in all cotton or silk and cotton mixed; fancy dress nets and guipure dress nets, all silk; Russian, *friquette*, Tosca, and dotted dress nets, all silk or silk and cotton mixed; striped and Fedora dress nets, silk and cotton mixed.

Miscellaneous.—Fancy cashmere laces and nets, woollen laces and nets, plain and mohair laces, Gigolette laces, braids, scarves, fichus, collars, flounces and gauzes, grenadines, torchon lace, and blonde laces.

Steps have already been taken by some of the largest and most enterprising of the Calais manufacturers, by the introduction of the so-called Plauen machinery, to actively compete with the manufacturers of Saxony and St. Gall. The great advantages to the lace industry from the geographical situation of Calais are manifested in more ways than one. The growing importance of Calais as a principal seaport of the north of France, which by the recent completion of the great and comprehensive scheme of harbour and dock improvements, in connection with its railways and direct system of canals throughout France, guarantees competitive and therefore cheap foreign and domestic supplies of coal, raw cotton, and the many things required by the resident lace manufacturers, and gives a corresponding and great advantage over all their inland competitors. The fact of Calais being the nearest seaport to Great Britain has firmly established the Calais and Dover continental route as the most desirable for the great number of buyers from all parts of the world, who can be so easily transferred from the boats, or connecting trains into the lace manufactories of Calais. There are at the present time about 1,850 lace machines in Calais, valued at about £418 each; with accessories or enclosing buildings, &c., at about £625 each, representing a capital of over £1,156,250. Between 600 and 700 of these machines are engaged in the making of cotton lace, and the remainder are particularly adapted to the manufacture of fine silk goods. These looms are distributed among about 350 manufacturers, and apart from 1,000 hands working on those making silk, and 600 on cotton, give employment to many thousands, in the various processes of winding, dressing, dyeing, cutting, mending, carding, packing, &c., and repairing of machines. It is almost impossible to give exact figures as to the number of the persons employed, and as to the amount of production it is very difficult to arrive at a proper estimate. Consul Shepard says that notwithstanding the dulness in the lace business, which has lasted for some years, it is hardly an exaggeration to put down the average yearly production of lace in Calais as valued at £2,500,000, of which one-half is silk and one-half cotton.

RUSSIAN NAPHTHA INDUSTRY.

Naphtha appeared in the character of a fuel only very recently in Russia, and quickly gained an extensive market, mainly in the Volga districts, and in the neighbouring industrial governments. The chief centre of the naphtha industry is in the Baku government upon the Apsheron peninsula. Fairly rich springs exist also in the Terek and Kooban territories. Naphtha is further obtained on the Transcaspian territory, in Turkistan, in the Crimea, and in some parts of the Caucasus. According to a report recently issued by the Chancery of the Committee of Ministers at St. Petersburg, the Apsheron peninsula gives about 98 per cent. of the total yield. It was not until about the year 1860 that the working of the naphtha fields attained any industrial importance, and the cause of this was that the processes for obtaining illuminating oil from naphtha were not sufficiently well known, and naphtha was employed exclusively in the crude state, either for burning or as a coarse lubricator. The mode of exploitation of the oil fields also served to hinder the development of their productiveness. At one time the Crown tried to work the springs on its own account, and when this did not succeed, it passed to the farming system, but the yield did not even reach two million pouds a year (poud = 36 lbs. avoirdupois). In consequence of this, from the year 1872 the naphtha industry was declared free, in adaptation to the general principles of mining legislation, photogen or illuminating oil being subjected to excise duties. From this moment began the unexpectedly rapid development of the naphtha industry. Increased boring brought to light immense quantities of oil, and the first considerable naphtha spring, which appeared in 1873, produced a complete revolution, the price of naphtha falling from 45 to 2 copecks per poud. The following figures show how rapidly this industry has grown:—In 1870, the output of naphtha for the whole of Russia did not exceed 1,750,000 pouds; in 1882, the yield was already more than 50,000,000 pouds; ten years later, about 300,000,000 pouds; and in 1894, 316,000,000 pouds, of which 309,000,000 were obtained in the Baku government. Not all this immense quantity of naphtha is consumed by Russia alone, which has increased the export of naphtha and its products from 1,000,000 pouds in 1881, to 60,000,000 in 1893. In 1894, the amount was 53,000,000 pouds. In value, this item of the Russian export trade has at once taken the first place after grain, flax, and wood. As to the extent of production, Russia has gained the second place to the United States, leaving all other countries far behind. Out of 300,000,000 pouds of crude naphtha obtained in the Apsheron peninsula, only 30 per cent. is offered in the form of lighting oils, the rest being mainly composed of naphtha residues, whereas, according to its qualities, the Baku naphtha might yield no less than 80 per cent.

INDUSTRIAL CONDITION OF EGYPT.

At Cairo and Alexandria there are a few metallurgical works, factories, and foundries owned by private individuals, but these are chiefly engaged in the work of repairing rather than of making machinery, and they are by no means in a condition to compete with European establishments. One of the largest works is owned by a Frenchman, one by a German, one by an Arab, and the rest by Englishmen. M. P. Rémy, Belgian Consul at Alexandria, says that a new establishment known as the "Société Metallurgique" has rencently been opened at Alexandria. A joint stock company has purchased some glass works which were originally owned by an Italian firm which could not however make them pay; and in view of the fact that the whole of the manual labour is to be provided by Europeans, and that all the raw material, even to the sand (for Egyptian sand is not fitted for glass making) must be imported from abroad, it is a little difficult to understand how this new company is to prosper and to successfully compete with similar establishments in Bohemia, France, Belgium, &c. The other industries actually existing in the country comprise pottery and brickmaking in the interior, particularly in Upper Egypt; a match manufactory belonging to a Frenchman at Alexandria; ice factories, oil works, and soap works at Alexandria, which successfully compete with the productions of Syria and Crete; cotton cleaning works throughout the Delta; rice cleaning at Rosetta and Fayoum; sugar refineries in Upper Egypt belonging to Daïra Sanieh, and to private individuals; and two large distilleries which have been established by Greeks at Cairo and Alexandria. There are other establishments which are chiefly engaged in producing imitations of the best known European products. Cigarette manufactories are rapidly increasing, and their products are exported all the world over; they employ a large number of workpeople, and yield considerable profits. This industry is almost exclusively in the hands of Greeks, one establishment at Cairo being a Belgian venture. Agricultural machinery and implements are entirely imported from abroad. The textile, dyeing, saddle and harness making, and jewellery industries are decreasing in importance from day to day, as they are crushed by competition and the cheapness of the European products. As a matter of fact, M. Rémy says that industry, properly so called, and as we understand it in Europe, does not exist in Egypt, and the stagnation in industrial production results from various causes, chief among them being want of capital, combustibles and raw material, the absence of intelligent labour and of machinery, and also of that activity and initiative which are characteristic of industrial people. Nevertheless, if it is impossible to establish in this country the more important industries, it would certainly be possible to work up the raw material that is found, and to utilise certain agricultural productions. For example, M. Rémy refers to sugar refineries which might easily be perfected and considerably augmented, while distilleries and oil works might well be extended. Cotton, wool, and silk factories might be established in a small way at first, and afterwards might be extended. Paper and rope factories would yield good results, for fibres and the raw material are cheap in Egypt. Water mills might be set up, and the waters of the canals and streams might be utilised as motive power. There is one industry which, in M. Rémy's opinion, might well succeed, that is beer brewing. An establishment brewing light Bavarian beer does not exist in Egypt. Beer is a beverage that the Mussulman religion does not forbid; the natives are fond of it, and at present they are unable to obtain it, as the prices of the imported article place it beyond their reach. An Egyptian national exhibition was held for the first time at Alexandria in 1894, occupying an area of about 8,000 square yards; but from an industrial point of view it was not of very great importance, little beyond what was already known, especially the rudimentary condition of Egyptian industry, being learnt from it.

HEBREW COLONIES IN PALESTINE.

The settlements founded by Russian and Roumanian Jewish exiles in the last decade were at first confined to Samarin, to-day called Sichrôn-Ja'akôb, and Rosch-Pinah, in Galilee. The United States Consul at Zurich says that like all new enterprises this one was subjected to many drawbacks. The colonists, formerly merchants or artisans, were inexperienced in their new occupation, and had no one to advise them. Mistakes in the selection and cultivation of the soil, and subsequent despondency were the natural consequences. Charitable gifts from the outside improved the situation. To-day, twenty-two villages, with an area of about 92,000 acres, have sprung up and flourished. The agricultural school, Mikueh-Israel, with an area of 593 acres, which serves as an experimental station and model farm, governs the colonies. The net earnings of this school are already sufficient to support all the teachers, as well as 100 pupils. The largest settlement is the village Sichrôn-Ja'akôb, which with an area of 4,942 acres, has 1,000 inhabitants, paved streets, a school-house in charge of five teachers, one synagogue, one physician, and one dispensary. The colonists grow principally vegetables and grapes for wine-making, and they also plant fruit trees and engage in bee culture. Mulberry trees are being planted with a view to silkworm culture in the future. The village of Rischol T'Zion, with an area of 22,239 acres, possesses already 1,500,000 vine stocks (which in 1894 produced about 210,000 gallons of wine), 20,000 mulberry trees, 10,000 fruit, almond, walnut, fig, and other trees. Each colonist possesses a stone house, with a vegetable and flower garden adjacent, a horse and cart, a cow, and an assortment of domestic fowls. In the other villages similar conditions prevail. At Gadrah, a settlement of former Russian students, a distillery for the manufacture of brandy is already in operation. Taking everything into consideration, the prospects are now good and encouraging.

UNITED STATES CAVIARE IN EUROPE.

After a careful investigation based chiefly upon information received from a firm in Hamburg which imports about 70 per cent. of the caviare entering Germany from the United States, the American Consul at Hamburg expresses the opinion that there exists a growing and profitable market for that article, not only in Germany, but in other countries of

Europe. The first importation of United States caviare into Hamburg was made 29 years ago, and the shipment consisted of from 20 to 30 kegs of 135 pounds each, and the price paid was about one penny per pound. The caviare came from the Delaware river, from which locality comes 50 per cent. of all the United States caviare now imported into Germany. Four thousand kegs of about 140 pounds each might be given as the total quantity. Both lake and river caviare are sent to Germany, chiefly from the Delaware river, Georgetown, Chesapeake Bay, the Fraser and Columbia rivers, the Great Lakes, and the Lake of the Woods. Lake Michigan has been exhausted. The supply from Lake Huron and Lake Erie has grown quite limited, while that from Lake Superior remains good. The largest quantity comes from the Lake of the Woods. Lake caviare is preferred to that from the rivers, on account of its larger roe, the latter being small and black in the river caviare. Nearly half of the imports of United States caviare is consumed in the cheap restaurants of Berlin, the remainder going to Austria, Italy, and other European countries. In Germany the imports are increasing, as the article commands a better price there than in the United States, and because the supplies of the Elbe and the Vistula are decreasing each year. Competition with Russia is possible on account of prices, and with Germany on account of the growing scarcity of the native product, and the larger roe of the American caviare. Holland exports a little caviare to Germany —about 500 pounds annually; the quality, however, is poor. United States caviare for the German market is salted in the United States with German salt, which is sent there for the purpose. It is claimed that this salt possesses preservative properties superior to those of American salt. Even the caviare from as far west as the Columbia river is treated with German salt.

General Notes.

Sanitation and Food Supply.—Mr. Louis Hanks read a paper lately before the Sanitary Institute on "Practical Sanitation in Relation to the Food Supply," in which he pointed out that the groups of industries most concerned are those respectively of the meat (including fish and game), bread, and milk trades, and indicated the means that should be taken to carry on these industries in a proper manner, clean linen and attention to the water supply being among the most important of these means. The author ended his paper with this summing up:—"The essence of sanitary teaching with regard to food is that the various articles should be procured from sources free from disease or disease-producing surroundings, that the produce should be systematically inspected and condemned if unfit for food before it is exposed for sale; that it should be shielded from accidental contamination or infection in transit or exposure for sale, that all premises devoted to the preparation or sale of food, especially meat, bread, and milk, should be sanitarily fit for such uses, and that cow-shed and dairy sanitation is of immense importance, not only as regards the susceptibility of milk to certain infective disease germs, particularly tuberculosis, scarlet fever, typhoid fever, and diphtheria, but also on account of the desired improvement in British dairy produce to enable us to compete on favourable terms with the scientific dairying of foreign countries such as Sweden and Denmark."

A New Russian Canal.—A deep and long canal is to be built by Russia, to connect the Baltic with the Black Sea. This canal, as projected, is to connect Riga, on the Baltic, with Cherson, on the Dnieper, near the Black Sea. It is to be 1,000 miles, long 213 feet wide at the surface, and 115 feet at the base, with a depth of 28 feet. According to a recent report of the United States Consul at Chemnitz, it is to carry the largest battleships of the world. From Riga the canal is to run into the River Dvina, thence by canals from Dvinaburg to Lapel, through the Beresina and Dnieper to Cherson. It is further projected to cover all the river regions with such a network of canals as will aid very materially in developing the whole surrounding country. Ships that went hitherto by way of the Atlantic, Mediterranean, and Sea of Marmora, taking more than twelve days, will now need less than six. Basins and harbours are to be built at all important points along the canal. Traffic is to be carried on day and night at a possible and permitted speed of about seven miles an hour. The cost of the canal is put down at about £20,000,000 sterling, but it is anticipated that it will cost a great deal more than this. It is to be ready for traffic in five years.

Pearl Fisheries of Lower California.—The value of the pearls found during 1896 on the coast of the gulf of California amounted to £70,000. Besides these, 5,000 tons of mussel shells were exported, the value of which was estimated at a further £250,000. According to a recent report from New York, pearl fishing forms the sole occupation of the natives, and La Paz is supported entirely by this industry. Until a few years ago only native divers had been employed, and the greatest depth to which they could dive was 35 feet. Upon the introduction of the modern diving apparatus a depth of 180 feet was accomplished; and whilst formerly the best divers could not remain longer than two minutes under water, a modern diver thinks nothing of staying two hours at a depth of 100 feet, although at a still greater depth the stay is necessarily shortened on account of the enormous pressure of water from above. Pearl fishing is mostly a matter of good luck, and this is its great charm for the natives. Most of the pearls which are found in the waters of Lower California are so-called seed pearls of a very modest value. The divers do not limit themselves to the pearl oysters; whenever they find a rare piece of coral or a new kind of mussel, they take these also.

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FRIDAY, OCTOBER 15, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

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INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.

The Report of the Proceedings of the International Congress on Technical Education, held at the Society of Arts in June last, has now been published—price 3s. 6d., by post 3s. 10d., and can be obtained on application to the Secretary, Society of Arts, John-street, Adelphi, London, W.C. The volume consists of 307 pages, and contains a report of all the papers read and the discussions, with appendixes giving lists of officials, delegates, and others taking part in the Congress.

Proceedings of the Society.

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CANTOR LECTURES.

MATERIAL AND DESIGN IN POTTERY.

By William Burton, F.C.S.

Lecture II.—Delivered January 25, 1897.

Having devoted the last lecture to an examination of the pottery made from and decorated only with natural clays, we must now commence the consideration of the important consequences that have resulted from the introduction of materials other than clay into the plastic pastes for the fabrication of other forms of pottery. As was briefly stated in the last lecture, the widely divergent forms of pottery known by the names of earthenware, stoneware, and porcelain, have all arisen from the continued efforts of potters to intensify by the addition of different ingredients, the varieties in colour, hardness, porosity, &c., manifested by different kinds of natural clays. Indeed at the present time the potter seldom works with a clay just as it is dug out of the earth, but strives, by judicious admixture of other materials, to compound a body for his pottery which shall have qualities seldom found in one and the same natural clay. Roughly speaking, we may group all the materials thus used, or that have been used, by potters in the composition of their more or less plastic pastes, as follows:—

Materials Used in Pottery Pastes.

1. *Plastic Materials.*—All the varieties of clay and marl.

2. *Aplastic or Hardening Materials.*—Sand, flint, quartz, ground pitchers, &c.

3. *Fusible Materials.* — Felspar, China stone, lime, gypsum, bone ash, barytes, artificial frits, &c.

The nature of the pottery paste produced will entirely depend on the choice of materials made from the foregoing, according as some particular property is required in the ware; and also, of course, on the proportions in which ingredients of the various classes are mixed together. The following Table will make clear the way in which such mixtures are used:—

Classificaton of Pottery Clays or Pastes.

1st Class.—Pastes containing only plastic materials or a mixture of plastic and hardening materials.

Examples:—Bricks, tiles, and the common red and brown wares of all countries.

The fired body always opaque, moderately hard, and generally strongly coloured, red, grey, or buff.

2nd Class.—Pastes containing plastic, hardening, and fusible materials.

Examples:—English earthenware, stoneware, granite and mortar bodies.

The fired bodies are dense, hard, generally opaque and white or pale in colour.

3rd Class.—Pastes containing plastic and fusible materials.

Examples:—Hard-paste porcelain, parian, &c..

The fired bodies are very hard, durable, and translucent, and, unless stained with added colouring oxides, white or creamy in colour.

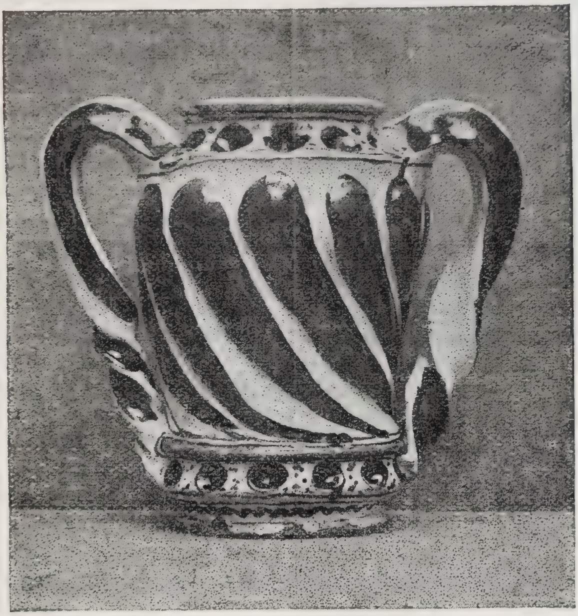
Putting aside now the simple earthenwares made from natural clay, we can conveniently enough for our present purpose group the remaining forms of pottery under the comprehensive headings of earthenware, stoneware, and porcelain, not that such names are of scientific precision, but because they mark with sufficient clearness for our purpose three great groups of pottery which in their typical forms at all events are clearly distinguishable. Leaving the porcelains and stonewares for subsequent treatment, we must now consider in such detail as is possible within the narrow limits of a lecture the causes which have gradually led to the production of such a material as white earthenware, by various stages of growth from the starting point of a common brown or yellow crock.

From a very early period there has been a demand for pottery whiter or lighter in colour than is generally furnished by naturally occuring clays. So soon as potters began to use painting, extensively as a method of decoration, they must have longed for some lighter ground to display their colours upon. This feeling was doubtless fostered by the introduction of glaze, for almost all earth colours are dulled and darkened by the melting of a glaze over them. Curiously enough, too, the very nature of the early glazes tended in the same direction, for as they seem to have been almost pure alkaline silicates, when they were applied to pottery made of ordinary plastic clays they would be very apt to bubble and scale, and chip. The potter found, in time, that this could be remedied by adding to his clay a considerable proportion of fine sand, and in this way Persian *faïence*, one of the earliest forms or pottery with a white ground, had its rise and origin. The vessels themselves were generally thrown or otherwise shaped in any ordinary plastic clay of the nature of kaolin or pipe clay, to which a considerable proportion of fine white sand had been added. The plasticity of the fundamental clay enabled the vessel to be made of good and true shape, while the white coating of siliceous slip, served the double purpose of enabling the alkaline glaze to melt more easily and to adhere more perfectly, and at the same time it furnished a white ground on which the potter could display to perfection those brilliant blues and greens whose use he was learning from the example of the worker in coloured glass or enamels, and the brightness of whose tints would have been entirely obscured on a ground of strong red or brown colour such as his uncoated clay would have given. A method possessing so many advantages as this would readily come into extended use, particularly in countries or times when the existence of large beds of clay naturally burning to a very light colour (like the Dorset clays of our own country) was unknown, and not only was this the general method or fabrication of all those Oriental earthenwares classed as Persian, Turkish, and Syrian *faïence*, but with the substitution, wholly or in part, of a coating of tin enamel in place of the siliceous slip, and with the addition of some silicate of lead to the alkaline silicate of the glaze, it was also the method of fabrication of the corresponding European wares, known variously as Hispano-Moresque wares, Italian majolica, the wares of Nevers, Rouen, and Delft, and was thus the essential method used in the production of nearly all the finer ware of Europe and the nearer East during many centuries,

Let us consider now for a moment the parallel wares of Asia Minor (variously known as Turkish, Rhodian, Damascus wares, &c.) and the well-known Italian majolica. The methods of fabrication and of decoration are closely allied; the vessel is shaped of some good plastic clay, the colour of which is immaterial, for it will be hidden by the opaque coating of siliceous slip or of tin enamel. The forms of the vessels thus produced are generally excellent, and eminently suited to clay work. Even where they seem to follow closely after the forms of metal vessels, it will be found, on examination, that the form has been generally adapted, or translated, rather than directly imitated—a feature which our modern potters, with their inordinate appetite for copying, would do well to take note of. It may be objected that the forms of these vessels are clumsy, and their walls thick and heavy when compared with the lightness and elegance of the Greek vase, but such criticism is beside the mark, for these vessels had to be made strong enough in the walls to bear immersion in slip while they were still in the condition of clay, and a thinner wall would have been likely to collapse or go out of shape. Moreover, the highest excellence of these wares lies rather in the elegance of their decoration and the beauty of their colour than in a severe perfection of outline, and many would agree that such slight sacrifice as was made in form was more than counterbalanced by these added glories. In fact, there can be no doubt that the constant endeavour of these potters was to produce the purest and most brilliant effects of colour possible, and while the methods were almost identical, the difference between the coating of siliceous slip with its covering of alkaline glaze on the one hand, and the coating of tin enamel with its covering of a glaze containing lead on the other, are quite sufficient in themselves to account for the striking differences between the palette of the Oriental potters and that of their European followers. If we arrange the colours actually used in two parallel columns, we get, putting all the colours used by each group of potters together, quite irrespective of whether they all occur on the same piece or not—

Mohammedan Pottery.	Italian Majolica.
Green and Turquoise.	Green and Turquoise.
Blues.	Blues.
Red (particularly fine).	Red (poor).
Purple.	Purple (rare).
Yellow (late period and always opaque and poor).	Yellow and Orange (particularly fine).
Black (for outlines).	Black (for outlines).

Fig. 5.



Gubbio Drug Pot.

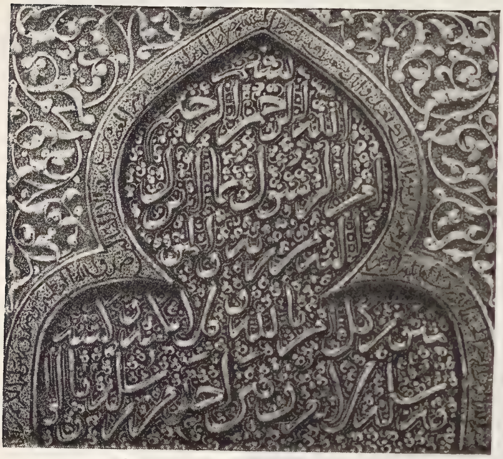
The blues and greens are strictly comparable in both cases, but the striking point to every one who compares these wares is the brilliance of the red and purple in the one palette, and the power and vigour of the yellow and orange in the other. This striking difference is in my opinion solely due to the slips and glazes above-mentioned. The siliceous slip and alkaline glaze would develop the red (made from Armenian bole) and the purple (made from manganese) to perfection; while the tin enamel and the leaded glaze would develop the yellow and orange tints (made from oxide of antimony and oxide of iron) to their utmost power, while the same pigments under the opposite influences would be either decomposed or very imperfectly developed. In fact we have here another striking instance of the control which the potter's materials exercise upon his doings.

We have already glanced at the influence which metal shapes exercised on the pottery under consideration, and remembering the extended use of moulds of plaster, bone ash, or baked clay among the Italian potters, one is perhaps apt to attribute to this alien influence certain decorative forms, which on closer examination are seen to be workmanlike expedients proper to clay. Such for instance is the round bossy modelling seen on many vases, dishes, and plates, particularly those which were intended for subsequent enrichment with lustre. The Gubbio drug pot figured above (498, '65, S.K.M.) is bossed up or indented very much as metal might be, but this form of embossing is even simpler to do in clay than in metal, and is obviously intended to display the brilliance of the lustre with which it is enriched, to the best advantage, while the twisted handles are emphatically clay.

It is interesting also to observe how the sgraffito method has a kind of counterpart in the bianco-sopra-bianco of the majolia painters. The result of this beautiful form of decoration is, after all, akin to the effect produced by sgraffito, but of course perfected and rendered much more subtle and dainty as becomes the increased refinement of material and method.

Still more interesting is it to find the device of slip painting so largely used for the production of rounded or bluntly modelled surfaces, as may be seen on many a dish border, and particularly on those Persian or Moorish tiles, where real or fanciful inscriptions are raised on the piece, to be aftewards heightened by the judicious use of lustre colour against a blue ground.

FIG. 6.



PERSIAN MONUMENTAL TILE.

One realises at a glance how beautifully slip would lend itself to a hand trained to write with a brush, and at the same time how the roundness produced by the natural flow of the slip was adapted to enhance the mysterious shimmer of lustre displayed upon it.

About the time, however, when Italian majolica reached its highest point, a fresh direction was given to the aims of the European potter by the first introduction of porcelain in any considerable quantity into Europe. This novel material, so wonderful and so strange, set all who were advanced enough, technically, to attempt its imitation. In spite of partial and promising successes at Venice and Florence, the course of European pottery was to remain for a long time one of imitation not of reproduction, and all the achievements of Rouen and of Delft in the 17th century were the result of constant endeavours to produce something like the blue and white porcelain of the Chinese, or the more brilliant decorations with red and green enamel. It is interesting to observe the old method of work attempting to adapt itself to new forms; the tin enamel becoming harsher as it was made more blue-white, the painting also becoming harder and less subtle, as the enamel coating and the ware were fired first before the application of the colour and the thin covering glaze, which was then fired at a temperature sufficiently high in most cases to sink it into the glaze. All this brought about a mechanicality of finish and a hardness of colour in great contrast to the *abandon* of the painting, and the juiciness of colour so characteristic of Italian majolica at its best, and undoubtedly paved the way for the uninteresting machine-made pottery, with its printed decoration (?) with which we are at present so familiar.

The same striving for a white body which had already produced such results abroad set the English potters to work in the early part of the last century, but they took a different course, for instead of resting content with an opaque white coating on a coloured body, they gradually brought to perfection a ware white throughout its substance, and so far resembling porcelain, but differing from it entirely in its nature and composition. The ware under consideration, English earthenware, has undergone various changes in its composition until it has become one of the most complicated of all pottery pastes. One kind of clay is used to give the plasticity, another to whiten it, ground flint is added to still further increase its whiteness and hardness, and a proportion of ground china stone or other fusible mineral is added, so that when fired the whole mass is cemented together into a hard, durable, and ringing mass. The glaze is generally a bright and limpid glass made by fusing together ground flint, carbonate of lime, carbonate of soda, borax, and white or red lead, so that this modern earthenware differs very widely in composition and properties from the older forms we have already considered. Wide and far-reaching as this change is, it is not greater than the corresponding change that has taken place in the entire *rationale* of pottery manufacture. Pottery in these modern days has become a highly organised industry, in which the united skill of artist and craftsman are brought under the influence of the commercial organiser, whose business it is to produce as large a quantity of goods made to one pattern as possible, and eschewing as far as possible the risks attendant on discovery of new methods, or the production of *chefs-d'œuvre* of artistic skill, proceeds on the safer, if less heroic, lines of reducing all his work to a constant system, in which every individual worker is trained to do his own piece of work, big or little, and nothing else. Artistically no doubt such a method may be deplorable, but before we proceed to condemn it outright, it is as well to remember that it is a necessary consequence of the improvements in machinery, and the more complete organisation of labour that has followed therefrom. It would be idle to judge modern pottery by the standards of the past: we are dealing with a new era, new methods, new ideals, and these must, it seems to me, be judged on their merits. It is useless to expect work as artistic as Persian or Italian *faïence*, save from the hands of some master like Solon or Deck, but the modern methods do give us plates, cups, bowls, and dishes of such a style and quality as regards their potting, at all events, as has never been seen before, and in such quantities and at such prices as make them articles of commonest use, and not of luxury. This is surely a legitimate province for the potter to fill, and what one can reasonably urge against him is not so much that his methods are wrong, as that they are used without sufficient discretion and taste. All modern methods, with the exception of printing on pottery, are but expansions or adaptations of the old methods used in producing the work we so much admire; but the potter has yet to learn that what is easy is not always desirable. The very fact that any result is easily obtained, should warn us against its indiscriminate use. Mechanical finish is so easy with the materials and methods in use nowadays, that it has been foolishly elevated into a sort of fetish, to the great artistic detriment of our work. We may however look forward, confidently, to the time when all this newness and crudeness shall have been assimilated and digested—turned into fruitful channels; and by making the artistic best, even of machine-made things, we shall reach a general style of modern pottery as worthy as the old, even if it be on a lower plane.

Lecture III.—Delivered February 1, 1897.

It was shown in the last lecture how the introduction of a coating of glass on the surface of pottery had produced the most far-reaching results. This influence was felt not merely in the decoration of pottery, but also in the whole *rationale* of the potter's methods. We must not, however, fall into the mistake of regarding the application and use of glaze solely from the decorative point of view. The most important reason for the use of glaze, and probably the one which first brought it into prominence, is a strictly utilitarian one, viz., that it serves to render ordinary pottery impervious to liquids. The importance of this point is most readily seen if we compare the ordinary plant-pot of unglazed clay with, say, an earthenware dinner plate. So far as the clay portion of these two kinds of pottery is concerned, we are dealing with substances which are both porous, and which, therefore, readily absorb water or any other fluid. The coating of the earthenware plate with glaze, which renders it impermeable by fluids, at once extends its usefulness, and marks a distinct advance in method. A moment's reflection must convince us how naturally glaze was resorted to as a means of producing pottery which could be used with cleanliness and decency for the purposes of the kitchen, the table, and the toilet. The widespread use of glazed wares would therefore follow naturally.

We have now, in this lecture, to consider a very important group of pottery, which, from the nature of its clay material, is not so dependent on a coating of glaze, and which may indeed be sufficiently impermeable without the addition of a glaze coating at all.

Certain clays, or admixtures of different clays, when fired to a high temperature, produce a form of pottery which, unlike ordinary terra-cotta, has a bright glossy surface. Further, if such pottery is broken, it is found to be semi-vitrified throughout its substance, instead of presenting the dull, earthy fracture, and the porous open structure of ordinary ware. Whenever pottery has made any considerable advances from its most primitive forms—that is, whenever reflection and experiment have led to the use of mixtures of various kinds of clay, instead of that one clay which came most readily to hand—hard fired pieces approaching more or less closely to stoneware have been accidently produced. An examination of the earliest pottery of Egypt, or of China, reveals many pieces possessing undoubted stoneware characteristics. It is interesting to observe, moreover, that the most antique pottery of the far East, pieces to which the Chinese themselves ascribe the highest antiquity, are small vessels of hard unglazed stonewares, generally dark brown or grey in colour.

The name "stoneware," so generally applied to pottery of this class, is in itself an excellent one, for most of the older specimens, at all events, have practically the colour, and the same even-ness of grain as a good freestone. The simplest members of this important group are only to be distinguished from earthenwares and terra-cotta by their greater density, and their diminished porosity. Owing to their partial vitrification they emit a much clearer and more ringing sound when sharply struck. At the other end of the group we find examples so white and translucent, as well as so vitrified, that they are hardly to be distinguished, even by an expert, from true porcelain, This group of the stonewares, therefore, forms the natural connecting link between earthenware and porcelain; and a knowledge of it forms the best possible preparation for a study of the highest form of pottery—the porcelains.

It has been already pointed out that the earliest stoneware pieces were obtained, perhaps accidently, by submitting certain clays to a fire of a greater intensity than usual. It is, therefore, advisable that we should briefly consider one or two points in connection with the behaviour of all clays under the action of fire. Clay, when fired, changes from a soft, plastic mass into a form of pottery possessing a greater or less degree of hardness, porosity, and brittleness. The extent of the change depends partly on the chemical composition of the clay, and partly on its physical structure. To take the latter influence first. The finer the particles of the clay the greater will be the hardness, and the less the porosity, of the pottery produced. A common device of the potter, consequently, for correcting a clay in this respect is to mix it with some neutral substance in grains of a perceptible size, as for instance with silica in the form of sand. This physical action—in which the grains of sand diminish the plasticity of the clay in working, and any excessive shrinkage in firing—is most useful in preventing the pottery vessels from warping in making, cracking in drying, or sinking out of shape in firing. It is commonly believed, too, that silica added to the clay, either in the form of sand or of ground flints, acts chemically owing to the production of less fusible silicates in diminishing its fusibility. This common belief of practical potters requires some correction. All clays are more or less impure varieties of hydrous silicate of alumina, and the fusibility of any particular clay will depend primarily on the ratio of silica to alumina in the clay. It can be shown experimentally that the most fusible clay-mixture is one in which the ratio is 1 of alumina to 17 of silica, or as it may be shortly expressed, $1Al_2O_3 17SiO_2$. If, therefore, we are dealing with clay containing a smaller proportion of silica than this, the addition of sand or flint may actually increase its fusibility. Such an action will only take place when the temperature of firing is sufficiently high to bring about actual chemical union. At lower temperatures the added silica will undoubtedly play its usual rôle of keeping the ware more open and porous. With stonewares, which are fired to a high temperature, this point is of the utmost importance, and the common use of sand in mixtures for stoneware-making is thus largely accounted for. The sand also plays another part. When stonewares are to be glazed, with a salt glaze, it is necessary that the proportion of silica in the body should be high, as salt glaze can only be perfectly obtained on a pottery which is rich in silica and poor in alumina.

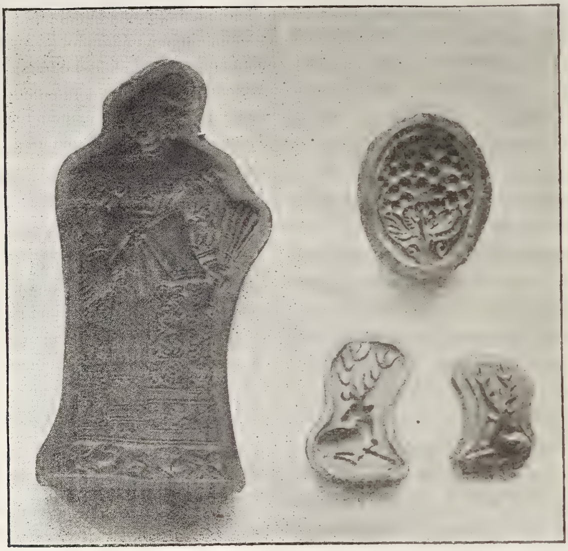
In early days stonewares, though often so vitrified as to need no glaze to enable them to retain fluids, were very frequently smeared, before firing, with a coating of ferruginous clay, which, melted at a high temperature, produces a dark coloured sort of glaze of a perfectly natural kind. This variety of glazed stoneware is largely made in most European countries for use among the peasantry, even at the present time. Its place has never been quite supplied by the finer and whiter modern earthenwares. Though ware of this simple kind was produced in many places both in Asia and Europe, it remained for the German and Flemish potters of the 16th century to elevate stoneware into a distinct and artistically important pottery group by the invention of salt glaze. This brilliant glaze, so unique in its method of production, so perfect in its agreement with the wares to which alone it can be applied, has made the stoneware group complete in itself, and quite distinct from either earthenware or porcelain, to neither of which can a salt-glaze be applied. All other forms of glaze can be traced back to remote beginnings in Egypt, Assyria, or China, but there is no trace of a process analagous to salt-glazing earlier than the 16th century. Everything points to the fact that the process was invented and brought to perfection in the very places where it was afterwards practised with so much artistic success.

To understand how salt-glaze differs so absolutely from other glazes, let us consider how the different glazes are obtained. For the ordinary glazes of earthenware or porcelain, a true glass or frit, as it is technically termed, is prepared by fusing together such materials as felspar, borax, whiting, and sand. This frit is ground to a fine powder under water, and the creamy glaze mixture is applied to the surface of the ware with a brush, or by several equally simple methods. The vessel so coated, being again fired, comes out from the kiln with the glossy coating we are so well acquainted with. In salt-glazing the process is entirely different. The ware, as it leaves the hands of the potter, is placed in the oven, and fired to a high temperature. At a suitable stage near the completion of the firing, common salt is either thrown on to the fires, or into the kiln, through special apertures reserved for that purpose. In either case the strongly-heated ware is entirely enveloped in sodium chloride (common salt) vapours, which at this high temperature react with the silica in the clay, forming a silicate of soda. As one of the constituents of this glaze—the silica — is an integral part of the clay, it follows that this silicate of soda becomes the outer envelope of the piece of pottery, forming a more perfect and intimate union with it than in the case of the ordinary glazes above described. It may be noted, too, that the production of this glaze necessitates only one firing of the ware, instead of the two usually given in the case of glazed earthenware.

Salt-glazed stoneware, though one of the simplest is one of the most technically perfect forms of pottery known. The glaze is brilliant, and from the very method of its production, most perfectly adherent to the body. It is so thin, too, that the finest and sharpest work of the modeller retains its crispness and vigour; offering a marked contrast in this respect to the thicker and more treacly glazes of earthenwares. Frequently, too, the glaze aggregates somewhat into more or less clearly defined drops, forming naturally those subtle and delightfully mottled surfaces known as "orange-skin" or "chicken-skin," which the Chinese potters have so laboriously sought to obtain in some of their choicest enamels. In the later centuries of the period, vaguely named the Middle Ages, true stoneware pottery, fired so hard as to be vitrified without the use of a glaze, was being produced at several little-known pottery centres, some in the German Rhine provinces, and others in Flanders. Early in the 16th century the process of salt-glazing seems to have been discovered, and the pottery at once rose to a higher level. The white wares of Siegburg, the brown pots of Raeren, and the later wares of Grenzhausen, decorated with blue and purple, must always take high rank in this branch of ceramics.

The actual methods of fabrication were generally of the simplest and most straightforward kind. Most of the shapes were *thrown* on the wheel, except some of the very elaborate and fancy forms, which, especially in later times, were occasionally modelled by hand throughout. It is interesting to trace in the various stoneware factories the progress of knowledge, and to realise how some of the simplest and most ordinary methods of the modern potter were unknown to the makers of these vessels. When a vase has been thrown on the wheel it seems to us the most obvious thing imaginable to cut it off the throwing-table with a string or wire; but in the early days, particularly at the Siegburg factory, it was customary to pull the vase off the wheel. A vessel so treated was, of course, mutilated about the base, and as the best way out of the difficulty it was placed on a sanded board, and pressed round the base with the thumb and fingers of the workman until it again stood fairly upright. This was the origin of the thumbed-foot so frequently met with in the early white pieces, and it is amusing to find this thumbing of the foot surviving even after the crude method of pulling the vase off the wheel had been abandoned. Another curious method used in the fabrication of certain of the shapes arose from the difficulty the early stoneware potters found in closing their shapes on the wheel. The prevalence of tapering cylindrical shapes, like the well-known "Canette," shows that such a form was an easy one to make; but the difficulty arose in making a vase with a rounded or globular body and bringing that up into a narrow neck. At Raeren, particularly, the difficulty was got over by throwing the vase in sections; the body of the shape would be formed by joining together with slip two shallow, thrown basins, and a neck and foot would be added, each part having been thrown separately. One also finds as a conspicuous feature, in many of the pieces of this period, the wreathed marks due to unequal pressure of the hands in throwing. The turner who finished off the vase in the lathe seemed to delight in gathering up and accentuating these, as it were, in the mouldings so freely (often without much regard to the particular shape of the vessel itself) turned on the neck and foot. If, however, the method of fabrication was simple and direct, the same cannot be said of the methods of ornamentation. Here, the ingenuity of the workman had a fine field to display itself in. Yet every method used seems to have been so admirably adapted to the qualities of the material, that one feels continually impressed afresh with the influence of the material itself upon the work.

FIG. 7.

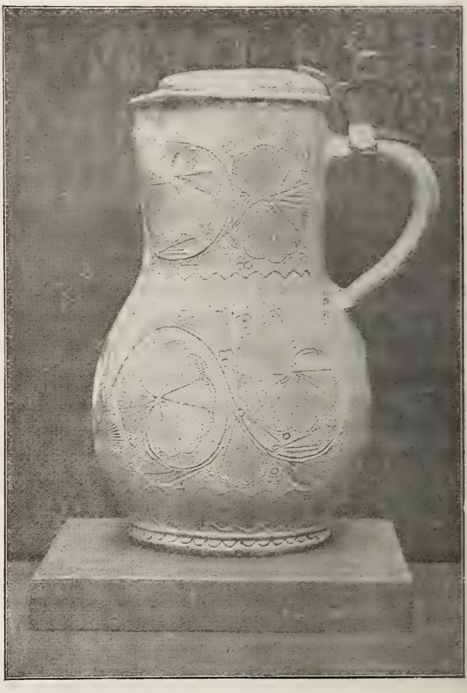


MATRICES FOR POTTERY.

The most general method of decoration was by the application of moulded reliefs. Nowadays, we should use a mould, which would give us, at one operation, the vessel itself with all its raised or sunk ornament complete. But closed moulds, such as these, appear to have been unknown. The vessel having been thrown and turned, was ornamented with reliefs of the same clay, which were pressed in flat, open dies or matrices. These matrices were either sunk in clay and then fired to harden them, or they were carved in a stone of fine grain—something like our lithographic stone—or in metal or wood. For the very best work the reliefs were pressed directly from the original matrices; but where many repetitions were desired, moulds were multiplied, and in this way the sharpness of the original work was very frequently lost. As these matrices were always carved in a flat slab of material, in order that the reliefs pressed from them might be conveniently bent so as to fit fairly to the curved outlines of the piece, they had of necessity to be made in small sections. Almost invariably the jointing of the ornament is painfully obvious; and the constant practice of separating the various figures or ornamental groups, with arcades and pillars, was a simple and convenient device for getting over this difficulty.

Another quite characteristic plan was the scratching of lines into the clay. At Meckenheim, in particular, this seems to have been carried to a fine pitch of perfection, as witness the jug figured here, from the South Kensing-

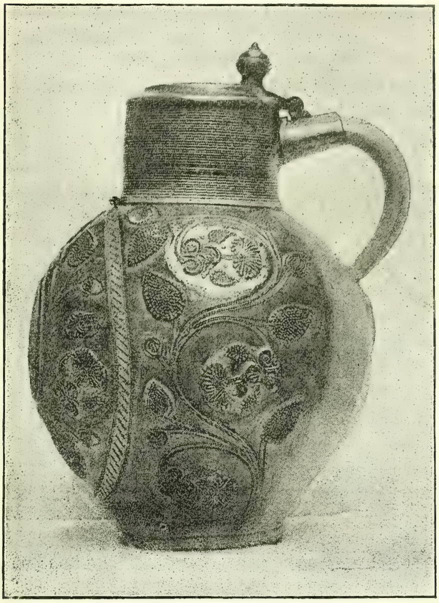
FIG. 8.



MECKENHEIM JUG.

ton Museum. This method has always seemed to me singularly appropriate to stoneware. The sharpness and precision which even the finest line retains, in a material so hard and so thinly glazed, gives a quality to this kind of work which would be entirely lost in any other material.

Fig. 9.



Grenzhausen Jug.

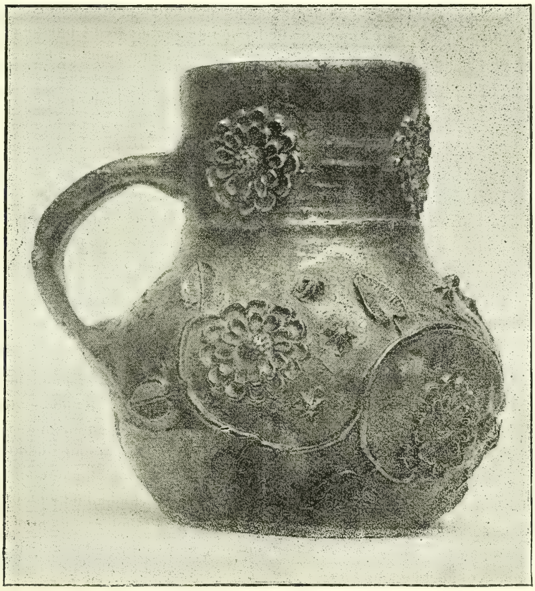
This scratching was carried a step further, and modified somewhat, at Grenzhausen.

In this case, the scrolls have been deeply scratched into the clay while it was in a fairly soft condition ; with the result that ridges are thrown up on each side of the furrow—the lines have, indeed, been ploughed. The ornamental forms of flower or fruit attached to the stems in this example have been formed in another way. A little dab of soft clay has been put in the required place on the pot, and has then been stamped with a seal, just as one might make an impression in wax. It is always easy to see the mark left by the edge of the seal in such cases as this.

Many of the Raeren pieces show incised ornament which has been clearly stamped into the clay, either with bookbinder's stamps, or with some strictly analogous tool. There can be little doubt that in the best stoneware period some of the makers were keenly alive to all sorts of contemporary relief work, and they took many a hint, if even they did not directly copy designs, from the works of the silversmith and the metal chaser.

As a rule we never find, on the work of the best period, decoration improvised on the clay vessel itself by the hand of the modeller. We do find however many late pieces like the one figured. Here the working potter has improvised his simple ornament of stem, leaves, and flowers. Most interesting is it to observe, too, that the actual method of work and the style of ornament were in this case precisely such as

Fig. 10.



Improvised Decoration.

would have been done by the potters of the same trict as far back as the time of the Roman occupation. Stems were made by working up a little roll of clay between the hands; leaves and flowers were simply modelled in the palm of the hand and then applied to the pot.

It would be possible to say much more concerning this most interesting and unique group of pottery. One ought to treat of the sparing use of cobalt and manganese to give the blue and purple colours so often associated with the kind of ornament shown in Fig. 9 above. Most unsatisfactory is it also to pass over the changes which followed on the introduction of stoneware into England about the end of the seventeenth century. Yet I can only say that the whole subject of stonewares has been so excellently worked out by Mr. L. Solon, that anyone really interested has only to consult his books to know all that words can convey on this matter.

Miscellaneous.

MANUFACTURE OF ALBUMEN IN CHINA.

An enterprising German firm has undertaken the manufacture of albumen at Chinkiang, it having been found that this place offered the best field for the business on account of the cheapness and plentiful supply of eggs. The factory is now successfully established, with possibilities of conducting it on a much larger scale. The country surrounding Chinkiang has always been noted for the rearing of fowls and ducks, and much attention is given by the farmers to this industry. The United States Consul at Chinkiang says that it is not an unusual thing for a farmer to have 4,000 or 5,000 ducks under his care. In China the duck is a fine hardy bird, a prolific layer, and requires little attention and less expense. The eggs are preserved, and will keep for ten and twenty years. The process of preserving is as follows:—A lye of bean stalk and lime is made by burning these to powder. This is put in water, black tea leaves and salt in certain proportions being added. The boiling is continued until all the water has evaporated and the residue becomes caked and hard. This is pounded and the fresh eggs are placed therein, one by one, with a little rice husk. These remain in the preparation 100 days, when they are ready for use. The establishment of the albumen factory referred to above has made a good market for the eggs, and the country people bring them in by thousands. The factory uses ducks' eggs in the manufacture of albumen in preference to chickens' eggs, solely on account of their greater cheapness. They are bought, not by the dozen, but by the thousand, the factory paying an average of 8 Mexican dollars per thousand. The process of the manufacture of albumen is by no means new, but is stated not to have been hitherto a financial success, owing to inability to utilise the yolk as well as the white of the egg. This difficulty has now been successfully overcome. As soon as the eggs are received at the factory, they are tested by a very simple, but ingenious, process. They are held in pairs in front of a circular opening in a tin cylinder open at the top, containing a lamp giving a powerful light, which is concentrated on the opening. Each speck and flaw in the egg is distinctly seen in this process, and all eggs showing the slightest sign of defect are at once rejected. The per-centage of rejected eggs is remarkably small, rarely amounting to fifty per thousand. The good eggs are sent to the rooms prepared to receive them, where a number of Chinese girls are employed to break them and to separate the yolk from the white, placing each into separate vessels. The white then undergoes one or two processes—it is either carefully cleaned of all stray clots of yolk and then put through a course of stirring in a large vessel by means of a heavy rod or paddle worked by hand, when it is ready for the drying-room, or after being cleaned, it is run into large vats and allowed to ferment, the process of fermentation being accelerated by the admixture of certain chemicals, which chemicals are held by the firm as a secret. When it is found in drawing off that all impurities have either been deposited or thrown off in the form of a thick froth, and the resulting liquid is albumen, as clear as water, the albumen is ready for the final process of drying. This is performed in a series of three rooms, each hotter than the last, the temperature ranging from 40° to 50° Centigrade. The albumen is run into shallow tin pans about one foot square, which are placed in ranges of shelves in the drying rooms. Frequent examinations are made to see that the temperature is maintained, and that the process of drying is sufficiently gradual, uniform, and complete, a period of sixty to seventy hours being found necessary for that purpose. When thoroughly dry the albumen, which now presents the appearance of isinglass, with a yellow tinge, is, after cooling, placed in large square packing boxes, lined with tin, holding about 400 lbs. each, and is ready for shipment. The principal use of albumen is in the preparation of fast dyes for superior kinds of cotton goods, and it is shipped to England, Germany, and France. The yolk of the eggs, after separation from the white, is passed through two sieves—one coarse and one fine—and it is then run off into vessels holding about 20 lbs. each, in the form of a yellow, even-running liquid of the consistency of rich cream. It is then poured into vats holding about 100 lbs., and a 10 per cent. solution of salt, borax, and an unrevealed chemical is then added for the purpose of preservation. The mixture is thoroughly stirred until it assumes the consistency of thick molasses and of a dark orange colour, and is then poured or, rather, forced through a funnel into a cask holding about 500 lbs. This is used in the preparation and dressing of superior leather goods, and is in great demand in England, Germany, and France.

BAVARIAN BEER INDUSTRY.

The kingdom of Bavaria is the centre of the beer-brewing interests of Europe. The United States Commercial Agent at Furth says that it is here that this beverage is found in almost lavish quantities, and as absolutely pure in quality as it is possible to be made, for the laws regulating the brewing and sale of beer are so strict, and are so rigidly enforced, as to render adulteration impracticable. Beer is regarded by the Bavarians, not merely as a beverage, but as a part of the food of the people, and, consequently, no pains are spared to keep the same positively free from impurities. The local laws provide for the closing of all other places of business on certain holidays, and during certain hours of Sunday, but no law whatever makes it necessary for the beer restaurant proprietor to close his doors at any time, Sunday or any other day; any effort to enact or enforce such a law would, it is said, meet with the most lively opposition from the people. The beer is sold everywhere throughout the kingdom according to measure; no one who offers beer for sale dare use anything but the standard glass controlled by the Government, holding exactly half a litre (·88 of an imperial pint). The glass to be genuine must bear a mark near the top with the fraction "$\frac{1}{2}$" cut in. There are, of course, one-fourth litre, and whole litre glasses, but these must also bear the marks and figures to indicate the size. The ordinary price asked for a half litre of beer is 12 pfennigs (about 1½d.). The price was fixed more than twenty years ago, when the Government made the change in its currency from guldens to marks. This of course is the retail price, the price at which the restaurants furnish the beer to their customers. The statistics bearing upon the beer industry of the country are interesting. According to the latest official returns there are in Bavaria 10,718 firms or individuals who brew beer. This number includes the regular brewers, or those who brew for the general market; the "commun" brewers, or those who take turns at the same brewery, and brew the beer they consume in their own restaurants; and "Haus" brewers, or those who brew for their own private use and not for sale. The number of regular breweries is 4,396; "commun" breweries 594; but the number of "Haus" breweries is not given, except in the districts of Schweinfurt and Bamberg where the number is 3,390. These breweries brewed altogether in the year 1895 (the statistics for that year being the latest published) 16,093,310 hectolitres (354,053,000 gallons) of beer. Of this enormous quantity 13,621,000 hectolitres (299,662,000 gallons) were consumed in Bavaria and the remainder exported. The beer is made from barley, malt, and hops, and in the brewing of the 354,000,000 gallons there were used 156,000,000 gallons of malt. The tax on this malt paid by the brewers to the Government amounted in the aggregate in 1895 to £2,000,000. The quality of the beer depends, of course, very largely on the quality of the hops used, and as this varies constantly and considerably, as shown by the price, it can be readily seen that to produce good beer no little skill and care are necessary in selecting this ingredient. The poorer grades of hops are not generally used, for as almost everyone in Bavaria is a judge of good beer, the brewer who would seek to profit by using a cheaper and poorer grade of hops would soon lose his business. The quantity of alcohol contained in the beer consumed is from 3½ to 4 per cent., but the export beer contains from 6 to 8 per cent. It is necessary to brew the latter stronger in order that it may stand transportation. There is a stringent law relating to the brewing and sale of beer. This law requires that "braun" beer, or the ordinary beer consumed in Bavaria, as well as exported, shall be made from barley, malt, hops, yeast, and water, and that no other ingredients shall be used, and if a brewer be found violating its provisions he shall be subjected to a fine ranging from 180 to 540 marks (£2 to £27), and, in addition, his beer will be confiscated and destroyed. This law is rigidly enforced. All beer is carefully examined and analysed by the Government officials, and it is therefore a matter of impossibility for the wrongdoer to escape.

MOLASSES AND PEAT FODDER IN GERMANY.

An interesting report has recently been made, by H.M. Consul at Stettin, on the subject of feeding cattle on molasses, and the advisability of mixing it with peat dust or "mull" for that purpose. The method of fattening cattle and sheep, by feeding them with molasses, has for a few years past been largely experimented on by agriculturists in Germany. One of the difficulties which has to be overcome, was that of obtaining the raw molasses with 50 per cent. of sugar remaining in it, in consequence of the molasses being subjected to a further process for the extraction of the sugar, after passing out of the original factory. Another question of even greater moment was the difficulty of finding a proper medium with which to mix the molasses, in order to counteract the purging effect which molasses alone, or in conjunction with some other feeding stuffs, exercises on cattle, when fed with it even in small quantities. It is found that the molasses, which have up to the present been in the German market, contain injurious salts, which are prejudicial to the health of beasts. The latter difficulty has apparently been met (although some are of a contrary opinion) by a mixture of molasses with a dust (mull) obtained from the moss-turf (peat). The moss-turf—from which the dust or mull is obtained by being torn up or teased out by a machine for making moss litter, called a "wolf"—is taken from the upper strata of high-lying peat moors, and consists largely of the dried but non-decomposed fibre of the *Sphagnum cuspidatum,* and the *Eriophorum latifolium.* The acids contained in the moss-turf, more especially the humic acids, neutralise the salts of proteine of potassium held by the molasses, and render them harmless; the action of the mull being to counteract the severe purging caused by the molasses alone, which is the chief objection to ts use as a fodder. It is recommended by experts that molasses-mull-fodder should first be given in very small quantities, and gradually increased to the following amounts :—Fattening cattle, 6 lbs. per head daily; milking cows, 5 lbs.; horses, 3 lbs.; sheep, for fattening, 1½ lbs.; sheep, 1 lb.; pigs (per 100 lbs. live weight) 1 lb. The following are the advantages stated by experimenters to accrue from the molasses-mull-fodder. It is 50 per cent. cheaper than the best fat-producing food, and yet equal in nourishment. It tends to keep the animal in health, helps the digestion, and whets the appetite. It is almost equal in nourishment to, and a good substitute for bran. It prevents colic and other sickness. It gives a glossy healthy appearance to the skin. In consequence of he large proportion of sugar it contains, it acts as a stimulant, and increases the working capabilities and stamina. With proper and careful use for milk cows it increases the production of milk while improving the quality. When used for fattening it increases weight and improves the flavour of the meat. It lessens the expenses of the farmer both in respect to fodder and as a manure, the large proportion of alkali in the molasses being especially advantageous in the latter. It will keep stored for an unlimited time.

Correspondence.

QUARTZ SLATE.

In the Society of Arts *Journal* for August last year [vol. xliv., p. 780], you advocated the use of quartz slate from Crummendorf, Silesia, as a substitute for the best firebrick. It may be interesting to some of your readers to have the following results of experiments made with this material.

No. 18 kiln was lined partially, that is with a band of 3 feet 9 inches broad, all round inside with this. It has been loaded and burnt off twelve times, and on examination it has been burnt half away, and the parts away from the fire have become brittle and can be easily broken by the tap from a mallet. No. 21 kiln was lined with firebricks at the same time. This kiln has been burnt off fifteen times without showing severe work. There is another objection to the quartz slate: it holds the heat to such an extent as to delay the drawing. These facts speak for themselves.

GERALD B. FRANCIS.

Bridge-foot, Vauxhall, S.E.

Obituary.

PETER LUND SIMMONDS, F.L.S.—The Society has lost an old and well-known member by the death of Mr. P. L. Simmonds, on the 3rd of this month. Mr. Simmonds's real name was Lund. He was born at Aarhuus, Denmark, in 1814, and was adopted by Lieutenant George Simmonds, R.N., whose name he took. Mr. Simmonds was a voluminous writer on technical and commercial subjects. In 1853 he published a volume on "The Commercial Products of the Vegetable Kingdom," and from that date, until within a few years of his death, he continued to produce a constant succession of books, which, if they were sometimes deficient in minute accuracy, were always full of useful information. Perhaps his best known works were "Waste Products and Undeveloped Substances," 1862, and "Tropical Agriculture," 1877. He was proprietor and editor of the *Technologist,* which appeared monthly from 1861 to 1866; and of the *Journal of Applied Science,* also a monthly publication, which was continued from 1873 to 1881. He also contributed regularly to many technical and trade newspapers. Mr. Simmonds was associated with many international Exhibitions both here and abroad. He prepared the catalogue of the collection of animal products made for the 1851 Exhibition, afterwards shown at South Kensington, and now at Bethnal-green. He served in various capacities in connection with the Paris Exhibition, 1878, and those of Melbourne, 1880, Amsterdam, 1883, Antwerp, 1885, and others of less importance.

He became a member of the Society of Arts in 1855, and in 1862 he was elected a life member, without payment, in recognition of the work he had done for the Society, and his services in the application of sciences to the arts. His contributions to the *Journal* have been very numerous, and include a great deal which does not bear his name. He read no less than sixteen papers before the Society on a variety of subjects, such as the "Utilization of Waste Substances," "Steam Navigation," "Gums and Resins," "Ostrich Farming," "Teak Forests," "Paper Making Materials," "Salt," &c., &c., and for three of these—viz., "Some Undeveloped Articles of Raw Produce" (1854); "Nuts: Their Produce and Uses" (1872); and "Timber Supplies of Great Britain" (1884)—he received the Society's medal.

In spite of his constant and laborious work he was never prosperous, and as advancing age rendered him incapable of the journalistic work which formed his main support, he fell into pecuniary difficulties. About five years ago some of his friends were successful in obtaining for him admission to the Charterhouse, a refuge which few can have better deserved. His end was hastened by an unfortunate accident. About a fortnight before his death he was knocked down and run over by an omnibus in the Gray's-inn-road, the result of which was that one leg was fractured and he received scalp wounds on the back of the head and forehead of a serious character. He was buried on the 7th inst., in the Charterhouse burying ground, Bow Cemetery, after a funeral service in the chapel of the Charterhouse.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CANTOR LECTURES.

ALLOYS.

By Prof. Chandler Roberts-Austen, C.B., D.C.L., F.R.S.

Lecture I.—Delivered March 15, 1897.

It is five years since the third series of Cantor lectures on alloys was delivered before this Society, which has always favoured researches connected with metallurgy. In the first series (1884), the alloys used for coinage were dealt with, while in the second (1888) and third (1893) courses, an attempt was made to group, as concisely as possible, the main facts connected wlth our knowledge of the constitution of alloys, and with certain of their industrial applications.

The present series will record the remarkable evidence of renewed interest in the study of alloys, which is indicated by the nature of the communications which have from time to time been made to scientific and technical literature during the last few years. Even the most solemn of our monthly Reviews, the *Nineteenth Century*, has recently opened its pages to an elaborate article on alloys, which are dealt with by Prince Kropotkin* as if they had long been the subject of general literary interest to ordinary cultured readers; while technical periodicals teem with paragraphs and articles on alloys, which would formerly have received scant treatment. What are known as the rarer metals are being eagerly sought for, and their influence on other metals is being investigated in the hope of their becoming useful when alloyed. Practical results of much importance have thus been obtained, but their nature will be considered subsequently, as the present lecture must be devoted to theoretical questions.

In the last four years great progress has been made in connecting the behaviour of metallic alloys with that of saline solutions, and it has become more and more evident that alloys may be divided into two main classes—(1) those which are merely solutions of the constituent metals, and (2) those which contain true chemical compounds; for while few alloys are true chemical compounds, most series of alloys contain compounds in solution. The first class is in some respects the more interesting.

Solutions are defined by Ostwald* as being "homogeneous mixtures which cannot be separated into their constituent parts by mechanical means." This definition will apply to alloys, and it is now well known that solids may truly dissolve solids, and therefore that solid solutions exist.

In the last course of Cantor lectures on alloys it was shown that much of the evidence as to the analogies of alloys to saline solutions has been derived from the use of either the resistance pyrometer, or that in which a thermo-couple affords a basis for measuring high temperature. In the latter case the thermo-couple is used in connection with an autographic recorder, and in order that this portion of the subject may be clear, a brief recapitulation of the facts stated four years ago must be given. A description of the autographic recorder has already been offered in this *Journal*,† and its construction is, indeed, now well known. In employing the thermo-couple fcr studying the molecular grouping of alloys, it is necessary to bear in mind what would happen if an ordinary mercurial thermometer be plunged into water which is losing its heat to a cold environment. The mercurial column would, as is well known, fall until the water begins to freeze, and then the mercury remains steady until the whole of the water is gradually liberated during the solidification of the forming ice, and the thermometer ceases to indicate a fall in temperature until the work of solidification is complete. The case is precisely the same when a metal is cooled down to its freezing-point. Suppose the thermo-couple is in connection with the autographic recorder, and is suitably protected—though this is not absolutely necessary—and is plunged into the midst of a little mass of fluid gold—some 30 grammes will suffice—which is being slowly cooled. The photographic curve registered by the recorder will be that shown in Fig. 1. Assume that the initial temperature of the cooling mass of gold is 1,500°, the temperature will fall, and the curve registered on the sensitised plate by the spot of light will, when the temperature of 1061° is reached, suddenly become approximately horizontal, as at A, and will remain horizontal until the mass of gold is solid, and then, but not until then, it will resume its downward course to the point at which the little mass reaches the atmospheric temperature. The same effect would be produced if the thermo-couple was placed in any other metal—lead, silver, platinum, or palladium—but in the case of silver and lead, the couple must be protected by clay from the direct action of the metal.

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* *Nineteenth Century*, February, 1897.

* "Solutions," by W. Ostwald. Translated by M. M. Pattison Muir. p. 1.

† *Journal of the Society of Arts*, vol. xli. (1893), p. 986.

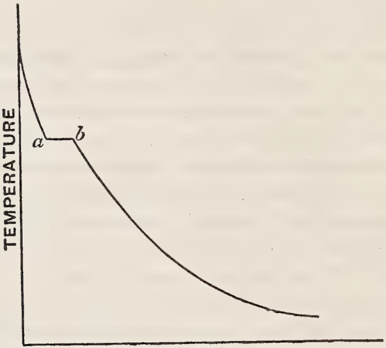

FIG. 1.

Hitherto we have only considered the case of a pure metal, but directly the mass is alloyed with even a minute quantity of another metal, quite a different set of molecular conditions is established, respecting which the autographic curves enable most precious information to be gathered. In fact, the purer the metallic mass is, the sharper will be the angle made by the horizontal portion of the curve, *a*, *b*, with the portions above and below it. The presence of an added element, even though its amount be apparently insignificant, is quite sufficient to destroy the sharpness of the freezing point of any metal which has as yet been examined. If the added metal is present in a very small quantity it apparently remains free, and usually lowers the freezing point of the mass, as will be hereinafter explained, but when a certain proportion of the added metal has been reached, it unites with a portion of the mass, and certain alloys, or groups of alloys are formed which fall out of solution as the mass cools, and the result is to change the nature of the cooling-curve, rounding its angles, and, in extreme cases, obliterating the horizontal part altogether. Such an extreme case is presented when two-tenths per cent. of aluminium is added to gold (Fig. 2). The horizontal part of the curve is practically obliterated, that is, there is no true freezing point. The normal curve for freezing gold would have followed the line (*a*, *c*), but the curve of gold, with two-tenths per cent. of aluminium, is that shown at *a*, *f*, with only a faint indication of the freezing of the mass, as a whole, at *f*.

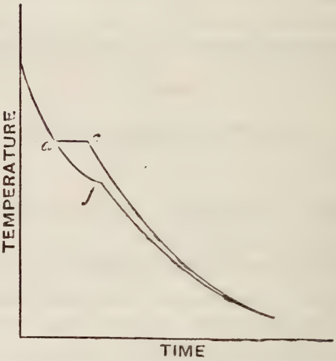

FIG. 2.

In this experiment the addition of only a small quantity of an added metal has been considered, and that from a somewhat limited point of view. The conditions are widely different, when the added metal forms a large proportion of the mass to which it is added. The case of the aluminium-gold alloys is very instructive. Suppose the apparatus to be so arranged that a series of cooling curves could be taken of alloys, in which the amount of aluminium added is considerable. Starting with pure gold, having a freezing point at 1,061°, successive additions of aluminium lower this point, and destroy the yellow colour of the gold, until the alloy containing 90 per cent. of gold and 10 per cent. of aluminium is reached, when the alloy is white, and freezes at 654°, or 407° less than that of pure gold, but then with further additions of aluminium the curve turns, the freezing point begin to rise, and when the amount of aluminium reaches 21·6 per cent., the freezing point is actually a few degrees higher than that of gold itself, and the alloy is a brilliant ruby colour. After this point is passed, successive additions of aluminium again lower the freezing points, and they appear to be lowered gradually until the freezing point of pure aluminium is reached. The case of the aluminium-antimony series, investigated for Dr. Alder Wright by the author, presents a similar case. Dr. Wright observed that the melting point of the alloy, containing

18·7 per cent. of aluminium and 81·3 per cent. of antimony, is considerably higher than that of its least fusible constituent the aluminium (654°). Accurate measurement by the aid of the curves, obtained in the way which has been already indicated, showed that the alloy, $AlSb$, has a freezing point of 1066°, or no less than 412° higher than that of aluminium. This aluminium-antimony alloy behaves like many true chemical compounds.

In the case of most alloys, as the mass of the melted alloy cools down, groups of alloys, which are atomically definite in composition, appear to fall out of solution, just as in a cooling mass of granite, atomically definite groups of minerals fall out, the mica and the feldspar, tourmaline, or whatever the grouping may be; but the fluid mass which remains need not be, and probably is not, definite in composition. The silver-copper series presents an excellent case in point, and so do the alloys of lead and tin, and it is satisfactory that this autographic method of recording the cooling of a mass of alloyed metal enables the whole history of the case to be accurately traced. Turn, for instance, to the tin-copper series, which comprise, industrially, a most important group of alloys. Alfred Riche* determined some of their melting points twenty years ago by the aid of a thermo-couple, which makes the hesitation of experimenters to employ thermocouples in such investigations the more remarkable, and, I may add, my own tardiness inexcusable. He considered that $SnCu_3$ and $SnCu_4$ alone possess respectively a single definite freezing point. It now seems that all the tin-copper alloys appear to have two solidifying points, while some appear to have three.

The bismuth-copper series yield very interesting and unexpected information when examined by this method.† It appears that, however small the amount of bismuth alloyed with copper may be, a certain proportion of the bismuth always remains free and does not unite with the copper at all. The cooling curve of any copper-bismuth alloy will, therefore, show at least two freezing points, the lower of which always closely corresponds with the freezing point of bismuth. The general nature of these curves is shown in Fig. 3, in which *a*, *b*, is a cooling curve of molten copper, containing about 10 per cent. of bismuth, while *c*, *d*, represents copper containing 30 per cent. of bismuth. It will be seen that there are two solidifying points in each, at *e*, *f*, and *g*, *h*, respectively, the points *f* and *h* being at the same temperature (268°), and are due to the solidification of the bismuth.

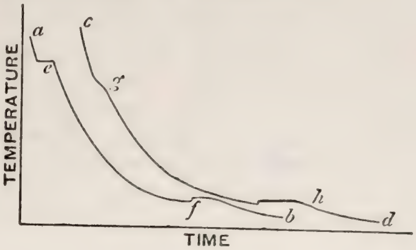

Fig. 3.

This case is one of true solution. To take the case of a single but impure metal, some recent advances in the evidence the curves afford must be recorded. Suppose a metal contains a small amount of dissolved gas, or of other impurity, which is insufficient to lower the freezing point materially (line *a*, *c*, Fig. 2), but only to round off the point *c* which marks the end of the solidification of the mass. A series of autographic records show that they may afford very precious information. The solution was initially a very dilute one, that is the metallic mass was nearly pure, but as it froze it rejected the impurity, driving it towards the centre, concentrating the impurity, in fact, until its influence was ultimately revealed by the rounding of the curve at *c*, by lowering that is the point of final solidification in a more pronounced way than the initial point. In some beautiful experiments conducted with the recorder by Mr. Stansfield on the solidification of gold in vacuo, the presence or absence of dissolved gas in the metal has been revealed in this way by a distinct break or step at the point *c*.

In the last course of Cantor lectures, I pointed to the curious property of metals called "surfusion," and it was stated that it is well known that certain metals will, if slowly cooled, pass below their freezing point without actually becoming solid, and that when solidification does occur, the liberation of the latent heat of fusion reheats the mass to the melting point, and in some cases causes it to glow vividly, even though it had previously fallen below redness. Pure gold, pure silver, and pure copper present such cases. All the earlier results have, however, been surpassed by the accompanying curve, Fig. 4, which faithfully reproduces an autographic record of the surfusion of metallic tin, and it shows that the metal actually fell to a point 20° below ts freezing point, and then became rapidly solid as the sharp rise of the curve indicates.

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* "Ann. de Chim. et de Phys.," vol. xxx. (1873), p. 417.

† "Proc. Inst. Mechanical Engineers," 1893, Part ii., p. 102.

The behaviour of very dilute solutions of metals will be further considered under the head of diffussion; for the present it will be well to turn to concentrated metallic solutions, and to take as a case the lead-tin series, Fig. 5,

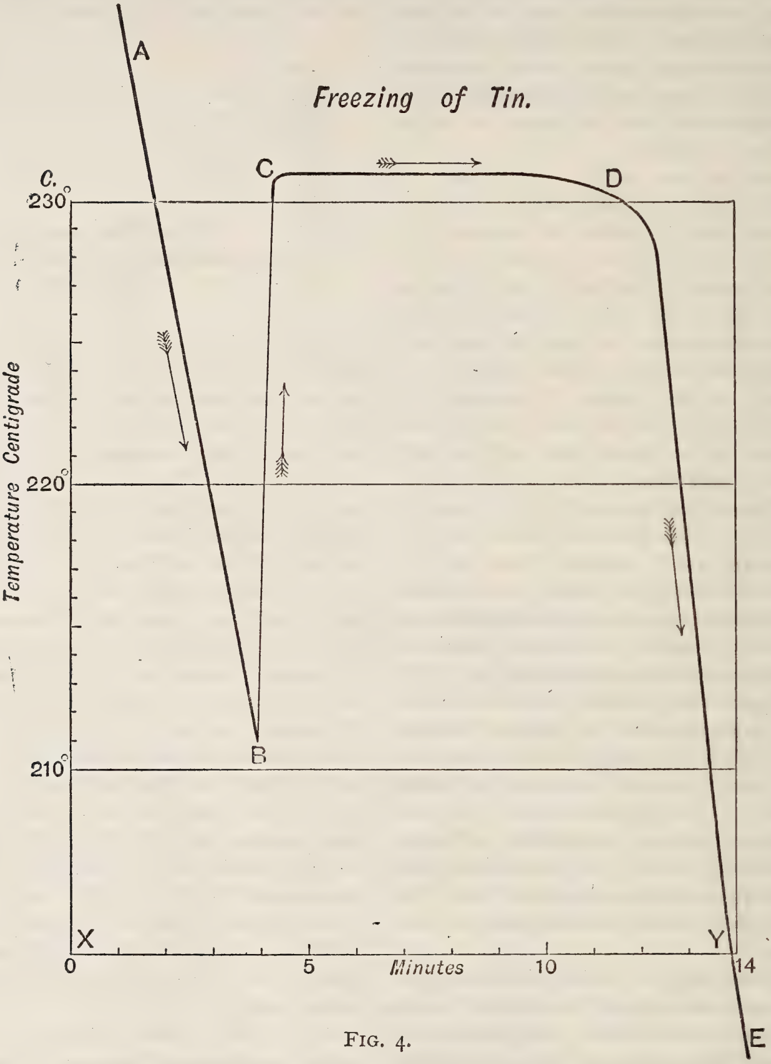

FIG. 4.

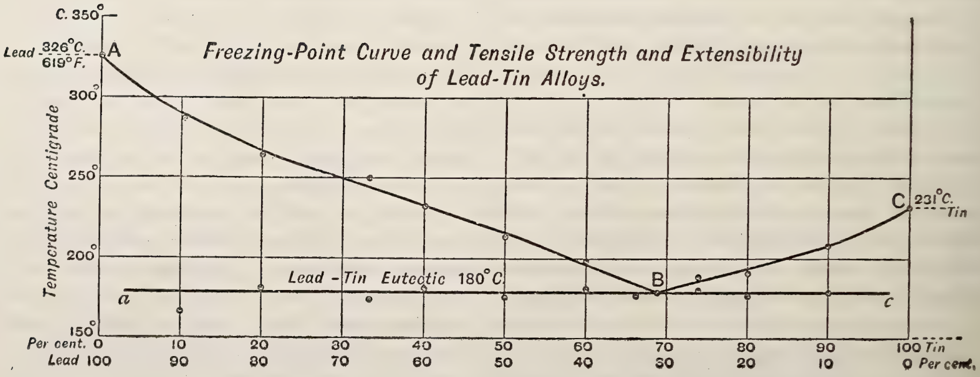

FIG. 5.

which belong to the first class of simple solutions. At a temperature near the melting point of lead, an alloy of lead and tin containing 50 per cent. of each metal would be entirely fluid, and the two metals would be in mutual solution. If the alloy were to cool down to about 220° solid lead would begin to crystallise out, the solid lead, the analog of ice in a saline solution, can exist in contact with the fluid so long as the temperature is kept constant. As the temperature falls more and more, lead crystallises out until at 180° the residue, which by this time contains nearly 70 per cent. of tin, solidifies as a whole. If the composition had initially been widely different, say if it had contained only 20 per cent. of lead, tin would have crystallised out before the lead.

A typical case of the second-class is one in which two metals, copper and zinc, are solvents not for each other, but for chemical compounds of the constituent metals. At a temperature near the melting point of copper, large quantities of zinc would combine with the copper to form, in the case of an alloy fairly rich in copper, the compound Cu Zn, and this would dissolve in free copper, and for each given mixture of copper and zinc there is a definite temperature at which the solid solvent is in equilibrium with the liquid portion. The freezing point, for instance, of an alloy containing 70 per cent. of copper, and 30 per cent. of zinc, proves to be 950°, and at this point the solid copper, the analog of ice of a saline solution, can exist in contact with the fluid alloy, without more copper being deposited from the solution, or more copper dissolved. At this point, the smallest abstraction of heat from the solution starts the solidification of the mass, and conversely the smallest augmentation of heat is followed by liquefaction. If the temperature is reduced, more and more copper crystallises out until at 890°, the remainder of the alloy solidifies as a whole. This residue is the mother liquor or the eutectic of copper, and the compound Cu Zn.

EUTECTIC ALLOYS.

In the curves which represent the cooling and solidification of most alloys, there are several points at which the direction of the curve changes, sometimes becoming approximately horizontal for a short distance. The first or uppermost of these halts or breaks usually represents the falling out of a more or less pure metal, or of some compound of the metal, from the cooling alloy. A second and sometimes a third break will be found on most of these curves; and these breaks indicate the solidification of eutectic alloy, that is, a fusible metallic "mother liquor" or bath, which solidifies at a definite temperature. In the copper-zinc series there are several of these eutectic alloys. It will be evident therefore that a curve drawn through a single freezing point for each alloy of a series cannot be claimed as complete. Such a curve is far from representing what actually happens during the solidification of the alloys of a given series, because comparatively few alloys become solid at a single point, while many have three points of solidification, and some have four or even five.

Guthrie* introduced the designation "eutectic" alloy to denote the most fusible alloy of two or more metals, comparing it to the mother liquor of a salt solution, which remains fluid after the bulk of the salt has crystallised out. The recording pyrometer shows that as regards alloys the case is really far more complicated. Many alloys consist, when fluid, of more than one solution; and each of the several solutions leaves, on cooling, a solid deposit and a fluid mother liquor. These mother liquors however do not usually unite with one another; and a complicated set of conditions is established, when the temperature has fallen sufficiently low for the whole mass to become solid. Each of these metallic mother liquors is a eutectic alloy, and may be included in the definition of eutexia actually given by Guthrie, although he does not appear to have been aware that there might be more than one eutectic in a single series of alloys. A "series" is here taken to mean all the possible unions which can be effected between two metals. Some alloys, such as those upon which Guthrie worked—the lead-tin for instance—are of a simple character, and when fluid have only one eutectic alloy, that is, the deposits fall out from a single mother liquor. (See Fig. 5.) All the alloys which are used for the sake of their strength appear to be highly complicated. Thus in the alloy of copper and zinc there are at least four eutectic alloys, and in the copper-tin series there are at least six.

It has been shown by Guthrie and others that the composition of eutectic alloys does not in general correspond with simple atomic proportions of the component metals; and indeed there are theoretical reasons for supposing that a eutectic alloy cannot possibly be a chemical compound. The higher point on the freezing-point curve, that at which the excess of either metal begins to solidify, indicates the solubility of one metal in the other, since it occurs at the temperature at which the solution is exactly saturated. Thus the freezing-point curve A B sloping down from the lead end of the lead-tin series in Fig. 5 indicates the solubility of lead in tin; while the curve C B sloping down from the tin end indicates the solubility of tin in lead. Where these curves meet at B, it will be obvious that both lead and tin will be deposited simultaneously by further cooling, and that the composition of the residual fluid alloy will remain unchanged. Thus the whole of this residual alloy solidifies at a single temperature, 180° C., and the lead and tin crystallise out side by side. There is, therefore, much reason for believing that when solidified, the eutectic alloy indicated by the line *a*, *c*, is merely an intimate mixture of the component metals.

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* "Philosophical Magazine," vol. xvii. (1884), p. 462.

MELTING OR FREEZING POINT.

The upper point on a cooling curve, at which the metal in excess begins to crystallise, is the point which has usually been termed the "melting" or "freezing" point; and difficulty has naturally been experienced in deciding what part of the long range of temperature, during which solidification takes place, should be called the true melting or freezing point of the alloy. In the previous reports alloys with more than one freezing point have been referred to. The temperature at which one constituent begins to crystallise out was called the higher freezing point; and the temperature at which the eutectic alloy solidifies was called the lower freezing point. It may appear at first sight as though these points must be merely the beginning and end of one continuous process of solidification. Even if this were so, it would be well to indicate both the beginning and ending of the solidification of an alloy, and not merely a sort of rough mean; but as, in the majority of cooling curves, the initial and eutectic freezing points are indicated by separate and distinct evolutions of heat, they may rightly claim to be separate, and not merely stages in a single operation. That this must be so may be deduced from any freezing-point curve: for it can be easily shown that, for any particular alloy, the greater part of the metal which is in excess crystallises in a short range of temperature below the initial freezing point. Thus, to take a simple instance from the lead-tin series of alloys, the alloy which contains 90 per cent. of lead begins to freeze at 290° C., and has a eutectic alloy at 170° C. The eutectic alloy, comprising one-fourth of the whole mass, freezes entirely at 170° C.; and of the remainder, which is pure lead, two-thirds freeze in the 25° C. which intervene between 290° and 265°, leaving only one-third to crystallise out during the remaining 95° C. of fall. It is therefore justifiable (1) to say that these alloys have two true freezing points; and (2) to adopt the eutectic freezing temperature and the *commencement* of the upper freezing range as the two significant points to record; while (3) for industrial purposes, such as the casting of alloys, it might be well also to indicate either the temperature at which the mass appears to solidify, or that at which any particular fraction, say one-quarter of the alloy, has solidified. The eutectic alloy contains a considerable proportion of each metal; and therefore the eutectic freezing-point line, which passes through the freezing point of the eutectic alloy of the series, extends both right and left of this point.

The fact that the lead-tin series has more than one freezing point is of industrial importance, for on it depends the facility with which an artificer can "wipe a joint" with plumber's solder. The latter contains 66 per cent. of lead, and its pasty condition when used is due to the fact that it has two widely-separated points of solidification, the alloy consisting of granules of solid lead in a fluid mother liquor.

It has been shown that the freezing-point curves afford clear evidence of the existence of solutions of metals. The freezing point of a metallic compound is usually lowered by the presence of an added metal, and as Heycock and Neville have shown in a remarkable series of researches the amount by which the freezing point will be lowered, can be calculated. Van 't Hoff, moreover, showed that in the case of saline solutions the composition of the solid, which separates out, can be calculated, but abnormal values for points of solidification are met with, and in the case of alloys, Heycock and Neville found similar abnormal values for the lowering of the freezing point of a metal produced by the presence of an added element. I also showed, so long ago as 1892, that the addition of aluminium to gold may raise the melting point, when a 22 per cent. of aluminium is present.* This was the first case of raising the melting point which had been detected.

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* "Proc. Royal Institution," 1892.

Küster has shown that the reason for the abnormal lowering of the freezing point is as follows :—The solution sets as a whole, because the solvent and the dissolved metal fall out of solution together.* The constituent metals in the mother liquor, and in the precipitate, bear nearly the same proportion, so that there is no tendency for the freezing of the solvent to be lowered. It may indeed be heightened if in such cases of simultaneous crystallisation the added metal has a higher freezing point than the solvent.

M. Osmond and I have developed similar views† on evidence afforded by the micro-structure of gold, to which certain impurities had been added. We concluded that when small quantities of certain elements are added to gold, the mass sets as a whole with the gold in which they are dissolved, and they need not separate out as eutectics, for in many cases the presence of such eutectics cannot be detected by the microscope as carefully prepared specimens with high magnification. In certain cases, however, the presence of eutectics is very evident.

It will now be well to consider the cases in which true chemical compounds are formed in alloys. Two or more metals may be simultaneously dissolved in a metallic solvent, and the dissolved metals may unite and form a true compound. Thus in the case of silver or gold dissolved in lead, I showed that if aluminium be added, the precious metal will unite with it and form a true compound $Au\ Al_2$, which is insoluble in the lead. The desilverization of lead by zinc, as in Parke's process, presents a case in point, the silver-zinc alloy which is formed is not soluble in lead. The question how far such compounds resemble ordinary saline compounds, which are known to dissociate in solution, demands careful study. A marked case is presented by the alloy $Sn\ Cu_3$, which the early experiments of Riche, almost the first made with a thermo-couple, seemed to show had only one freezing point. Autographic curves taken with the recording pyrometer, nevertheless, revealed the presence of a eutectic alloy in a mass of $Sn\ Cu_3$, which had been allowed to solidify slowly. As masses of copper-tin alloys, richer in copper than $Sn\ Cu_3$, cool down, there is abundant evidence of dissociation.

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* *Consult* "Solid Solutions," by Dr. J. Walker. "Science Progress," vol. 5, 1896, p. 121.

† "Phil. Trans., Royal Soc.," 187A, 1896, p. 417.

CANTOR LECTURES.

MATERIAL AND DESIGN IN POTTERY.

By William Burton, F.C.S.

Lecture IV.—Delivered February 8th, 1897.

To the ordinary observer there is little or nothing in common between a piece of terra-cotta and a piece of flint glass. The chemist, however, finds them to be merely distant members of the same great family of artificial substances. Every form of baked earth, and every form of glass, belongs to the group of silicates, *i.e.*, substances in which silica is united with earthy, alkaline, or other metallic bases in widely varying proportions. The exact position which any particular product will occupy in this gamut—of which the lowest note is crude baked earth, and the highest, say, the paste of artificial gems—is almost entirely a question of what particular base, or group of bases, the silica is united with. A preponderance of alumina characterises the pottery members of this group, while a preponderance of alkalies or of lead is equally characteristic of the glassy members. It is of the utmost importance to bear in mind that the gradations are so small that it is impossible to draw any sharp dividing line within the group itself, and though it is easy to distinguish between terra-cotta, porcelain, and flint glass, these shade off into each other in such a way that it is impossible to say absolutely where one ends and the other begins. We have already considered how stoneware differs from earthenware, or terra-cotta, in exhibiting partial vitrification throughout its substance. When this point was under discussion, in the last lecture, mention was made of the fact that the stonewares thus formed a kind of stepping-stone between the earthenwares and the porcelains. In porcelain itself we find the connecting link between what is plainly marked as pottery and what is no less plainly marked as glass, for porcelain may be regarded either as a pottery rising to transparency, or as a glass descending to opacity. Bearing this well in mind, we shall be prepared to find in the working properties of porcelain a considerable divergence from the working qualities of ordinary clays; and, consequently, that the potters' methods have undergone much modification to fit them for dealing with this new substance. It was stated in the first lecture that it would be idle to speculate on the place of origin of simple pottery, as all the materials and the requirements needed for its production abound everywhere. When we reach the most highly specialised forms, however, such as salt-glazed stoneware, or hard-paste porcelain, it becomes possible to refer them to a centre of origin with almost absolute certainty. The Chinese origin of porcelain is possibly indisputable; at all events, we can safely say that all European porcelains were produced in conscious and avowed imitation of the Oriental product. In further support of this point, one may remark that nothing in the previous European practise seems likely to have given any hint which might have led to an independent European origin of this remarkable product. When European potters first became acquainted with Oriental porcelain, they made the most absurd and fantastic guesses as to its origin, composition, and properties. Its translucence gave them a hint as to its relation to glass, and it is therefore not surprising that Venice, so famous for its glass, even in the early Middle Ages, should have striven to penetrate the secrets of its manufacture. Documentary evidence would seem to show that a translucent porcelain was made at Venice in the 15th century, but, in the absence of undoubtedly authentic pieces, it is impossible to say much as to the ware. Porcelain was certainly made in Florence, under the patronage of the Medici, about the period 1575-80, and quite a number of pieces of this manufacture are known. Although the pieces are of a good, creamy-white colour, with a beautiful rich glaze, it seems probable that the work was little more than a *succès d'estime*; and it was not until the early part of the 18th century that the continuous experiments made in France and Germany resulted in the production of European wares, in any considerable quantity, which could bear comparison with the porcelain of the East.

As a result of all the experiments made in Europe in this direction during the last four centuries, we have now three kinds of ware, all of which are termed porcelain, though they vary considerably in their composition and properties.

First.—True kaolinic, or hard-paste porcelain (Fr. *pâte dure.*) To this class most of the Oriental porcelains belong, as well as the hard-paste porcelains of Europe, *e.g.*, such as those of Dresden, Berlin, and Sèvres. The fusible material in this body is mainly felspar, with some small addition of alkalies.

Second. — Artificial soft-paste porcelains (Fr. *pâte tendre*); early French porcelain, old Worcester. The translucence is obtained by the addition to the clay of a very large proportion of glass, and the material altogether approaches glass more nearly than any other form of pottery.

Third.—Natural soft-paste porcelains; all modern English porcelains. The translucence is obtained by the addition of a large proportion of bone-ash to the kaolin and felspathic material. The body thus produced becomes translucent at a much lower temperature than in the case of hard-paste porcelain.

Certain French writers have endeavoured to show that the term porcelain should only be applied to those forms of translucent pottery which owe their fusibility to felspar, or purely felspathic material alone. For my own part, such restriction of the use of the name seems more pedantic than sound. The point which every maker of porcelain has to solve, is the production of a mixture of clay and fusible materials which, under the conditions of his firing, will burn to a translucent pottery without ruinous loss. This, of course, brings together in one group not only all the varieties of porcelain, but also such substances as the translucent and highly vitrified bodies in which Josiah Wedgwood executed his well-known bas-reliefs. In these jasper bodies, as they are called, the fusible material is barytes and not felspar, but that, after all, is a purely chemical detail, and, judged by the results of appearance, density, vitrescence, and hardness, these jaspers undoubtedly belong to the porcelain group. It may be as well also to remind the purists that the Chinese themselves have made porcelains of very different compositions; for not only have they made well known soft pastes, containing a large proportion of glass, but they run the whole range of bodies, from well marked stoneware to glass, in a way that makes any statement about their typical porcelain body very unreliable indeed.

Remembering, that in porcelains of every class, the clay material used is kaolin, one of the least plastic forms of clay, and further, that the kaolin is mixed with a very large proportion of fusible matter, which possess no plasticity, we shall be prepared to find many points of technique in which porcelains differ from the more ordinary forms of pottery.

To commence with, the plasticity of the mass used for porcelain (and on this point all porcelain bodies agree) is far less than that of ordinary clays. The ordinary operation of throwing is more difficult, and is, therefore, not so extensively used. Porcelain articles are generally smaller than the corresponding earthenware pieces, and when a large piece is required it is very often built up from separately thrown or moulded sections, as in the method of making stoneware pieces used at Raeren, and described in the last lecture. Very often, too, a rough shape is thrown, and is then placed inside a plaster mould, which drops into a socket on the wheel-head. This is then set revolving, and by gradually working the clay up the inside of the mould, the latter supports it in such a way that a much taller piece can be made than could be obtained by throwing in the ordinary way.

The want of plasticity of the porcelain clays has led to the adoption of many expedients for improving them in this respect. Probably the oldest and the best of all these expedients, apparently in extensive use among the Chinese too, is what is known as "ageing" the clay. After the mixture has been made into clay, it is kept a long time—the longer the better—in a damp pit or cellar, where it can be occasionally watered, beaten, and turned over. Certain putrefactive changes go on, probably originating from the decomposition of the small quantity of organic or sulphurous compounds present in most clays; a slight evolution of gas takes place, and by the repeated beatings and waterings, the particles become smaller and more uniformly aggregated, so that after a certain time the clay undoubtedly works with greater smoothness and mellowness. The same results are apparently brought about much more rapidly by a method formerly in vogue at Sèvres. The clay is thrown on the wheel in lumps of a considerable size, which, after extended manipulation by the thrower's hands, are set aside to dry. The lumps are afterwards shaved down into thin slices, and re-made into clay by beating together with water. This cycle of operations being repeated many times, is said to produce a considerable improvement in the working qualities of the clay. The simplest method of all is to add soap, glue, or size to the clay, to bestow on it a kind of fictitious plasticity. All these methods, however, are only attempts to make the material do more than it is naturally disposed to do. It would be a better and more frankly workmanlike proceeding to recognise the fact that the porcelain material is deficient in plasticity, and that it should only be used for such articles and processes as its nature fits it for.

The very qualities which render porcelain clay deficient in plasticity, admit another method of fabrication, which is entirely right and useful, viz., the method of casting. Many writers of books and articles on pottery have gone out of their way to stigmatise this process as entirely false in its application to clay work at all, apparently confounding it with metal casting. Now, as a matter of fact, casting is just as right and true a clay process, when applied to substances like porcelain, as throwing is in the case of plastic clays. The process is simply this: the porcelain slip (*i.e.*, clay in suspension in water) is poured into moulds of plaster of Paris, or some other absorbent substance. The mould immediately begins to absorb water from the slip, and the clay particles which were held in suspension by that water deposit themselves on the inside of the mould, forming really a cast of it. When the workman judges this deposit to be thick enough he pours out the still fluid portion of the slip from the mould, which is then put aside, with its adherent slip cast, to dry. In drying, the clay cast contracts, and when sufficiently firm to bear handling, can be removed from the mould. It is found as a matter of experiment that the more plastic clays do not cast so easily and so well as the less plastic ones, and we may therefore without doing violence to the truth regard the two processes of "throwing" and "casting" as being particularly applicable, and therefore right in use, the one to plastic clays, and the other to clays deficient in plasticity.

Let us consider, now, how the points we have just been discussing have affected the form of porcelain vessels. An examination of a group of vessels, either Oriental or European, will reveal the fact that porcelain shapes have a tendency generally to the cylindrical; that as compared with the classic pottery shapes they are wanting in grace of curve and flow of line; and that frequently also they seem to be based on shapes proper to metal. There can be no doubt that the main cause of all this is the want of plasticity already alluded to, but another contributory cause is to be sought doubtless in the source from which so much of the porcelain inspiration has been derived. It is only natural that the European having made porcelain in imitation of the Chinese, would be likely to give his vessels the form as well as the appearance of the originals. The Orientals have never excelled in the shapes of their pottery, and they seem to take a positive delight in reproducing a shape proper to one material, in another of quite different properties. Add to these influences the extended use of the mould in throwing, pressing, and casting; and the building up of a piece by the luting together of several separately made sections, and I think we can sufficiently account for the well marked distinctions of shape in porcelain and in earthenware.

The handles and feet of porcelain vases, too, offer a marked contrast with those of earthenware and stoneware. In a really well made earthenware vase, it is always interesting to observe how the lines of the foot and handle grow out of those of the body, so that the piece is an organic whole. In porcelain, however, one never gets away from the fact that they are stuck on. The handles, for instance, frequently give one the feeling that they have been stuck on as a kind of afterthought to fill a space, or break a too obtrusive line. Very frequently, too, they are frankly imitated from metal work, and in many examples of both Sèvres and Dresden work, the handle has been deliberately made of metal, and fastened on to the vase with rivets or bands. This strikes me as a most unworkmanlike proceeding, the natural consequence of trying to do more with a material than can be easily and rightly done. The foot, too, particularly in Chinese work, looks too often like a ring applied to the base of the vase, resembling indeed the rings by which pieces are supported during the firing. This is a natural consequence of the fact that porcelain so easily sinks out of shape in the firing, and anything in the nature of an attenuated foot-stalk is quite inadmissible. The result of this treatment, however, is that the foot generally looks too heavy for the thin, light vessel which it carries. The Chinese ssem to have been much more alive than their European rivals to this defect, for we frequently find the feet of their vessels delicately and cunningly pierced so as to give an effect of lightness, without impairing the strength of support.

The decoration of porcelain, too, demands treatment at our hands, for in many respects it differs widely in method, as well as in quality from that of the other forms of pottery. The important factor, in all pottery decoration, is the nature of the glaze. In soft-paste porcelain, both the artificial French variety, and the natural English variety, the glaze is not substantially different, either in composition or in application, from the glazes of earthenware. In hard-paste porcelain, however, whether it be Oriental, French, or German, the glaze differs so entirely both in its composition and its method of application, as to demand special consideration. In earthenwares and in soft-paste porcelains, the first firing of the ware, the biscuit firing as it is termed, is carried to a comparatively high temperature, and the second firing, to melt the glaze, is not nearly so high. In hard-paste porcelain, the first firing is merely to a dull red-heat; just enough to harden the vessel sufficiently to bear handling. The vessels are then coated with a glaze consisting of little but felspar, and submitted to a sharp and most intense fire (greater than the biscuit fires of ordinary wares), which suffices not merely to melt the felspathic glaze upon the ware, but causes it to penetrate the ware to an appreciable depth. As a result, the glaze and body become more perfectly incorporated than in English porcelain; indeed, they approach very closely the physical condition of the body and glaze of salt-glazed stoneware.

The felspathic glaze used developes underglaze colours, or colours dissolved in the glaze, to the greatest perfection; this is a result of its chemical neutrality. But owing to the very high temperature at which it must be fired, the number of colouring compounds which can support such treatment is very limited. Oxide of cobalt, oxide of chromium, and chromate of iron are almost the only base usable, so that the underglaze palette for hard-paste porcelain is almost restricted to blues, browns, greens, and black. This is the reason why blue and white is such a favourite colour scheme on Oriental porcelain. The Chinese, too, have made great use of coloured glazes, *i.e.*, glazes with colouring matter dissolved in them; and their *céladon*, *sang-de-bœuf*, *rouge flambé*, *turquoise*, and lilac glazes remained unapproached, until the recent work of certain French ceramists gave us European products not unworthy of comparison with them.

This curt limitation of the underglaze palette led the Chinese to the discovery of overglaze colours, a process they had brought to perfection prior to the introduction of porcelain into Europe. In this process the colouring base is mixed with a considerable proportion of very fusible glass. The pigments thus obtained are painted on the already fired glaze, and the piece is then fired again at a moderate heat, in a muffle furnace. The flux used in the pigments melts and becomes more or less perfectly incorporated with the glaze, thus serving as a vehicle to fasten the colour on to the surface of the glaze. The process is strictly analogous to glass painting, and has nothing in common with true ceramic colour, but owing to the largely extended palette obtainable by this method, over-glaze painting has come into extensive use not only on the glazes of porcelain, but also on earthenware, and even on stoneware. This is undoubtedly one of the deplorable results which has followed from the introduction of porcelain into Europe, as it has led to the general substitution of hard, thin, scratchy overglaze painting in place of the rich and juicy colour produced when the colour is used underglaze, and is perfectly taken up and vivified by the glaze itself. However valuable an adjunct this process may be to the hard-porcelain painter, its extended use on soft-paste porcelain and on earthenwares, where an underglaze palette wide enough for every decorative purpose is obtainable, can only be deplored.

One feels, after all, that though the establishment at Sèvres in France, and Messrs. Minton in this country, can produce porcelain of their respective kinds that leaves nothing to be desired in practical knowledge, and perfection of workmanship, porcelain remains still a foreign and not an indigenous product. The European potter stands without a rival in the production of earthenwares and stonewares, but the true porcelain influence still reigns in the East.

Miscellaneous.

COTTON CULTIVATION IN PERSIA.

The cotton plant appears to be indigenous to the soil of Persia, and will thrive in almost any part provided a favourable soil can be found and a sufficient water supply for irrigation be procured. It flourishes in the humid clearings of the dense forests that fringe the southern shores of the Caspian Sea and grows equally well in the fierce heat and glare of the central plains. Cotton was grown and utilised at a very remote era of Persian history. The United States Consul-General at Teheran says that the mode of cultivation has probably continued almost unchanged from early times. The following is the method usually observed. The fertilising material used on land devoted to the cultivation of cotton, contains strong alkaloids, and is collected from cesspools, and in consequence of the scarcity of the manure supply cotton is not sown on the same land two years in succession. A year's fallow is considered necessary to give time for recuperation. If a second crop is sown the following year the result is a very indifferent quality and is not considered sufficient to compensate for the labour bestowed. From the time the plants have attained a sufficiently sturdy growth to support the effects of the fierce summer heat until the cotton is matured and ready for harvesting it is subjected to a varied irrigation. If the land be of a sandy or loamy description and free from an underlayer of stone or gravel, and bordering on the supplying stream or river so as to absorb a quantity of moisture, the plants are irrigated every fifteen days; if however the same conditions of soil exist at a distance from the stream then water is turned on every twelve days. If the ground on the other hand be of a gravelly or of a very absorbent nature, whether it be near or far from the principal stream, it has to be watered every seven days. Planting usually commences in the beginning of April and continues according to the varying circumstances of situation and latitude for about a month. The harvest begins about the 21st September and is finished before the end of October. The picking of the cotton resembles the method pursued in other countries. As soon as the cotton shows signs of maturity the pickers go amongst the plants and collect the cotton from the capsules as fast as they ripen, putting it into bags tied round their shoulders for that purpose. It is then taken home and laid out in the sun until it is quite free from moisture. When the whole is gathered and dried it is then put through the cleaner, which consists of two parallel rollers, between which the cotton passes, and a box to receive the seeds. This, however, is not a very efficient contrivance, and the cotton has to be released before it can be applied to the manufacturing process. One machine will clean about 100 lbs. in the course of a day. All cotton is spun for manufacturing purposes by hand-wheel and generally by women and girls, who are taught the work at a very early age. The seed of the cotton is mostly given to camels, which like it better than any other kind of food. In the town of Ispahan and a few other places oil to a very limited extent is extracted and used for lighting purposes, but this has not yet assumed such dimensions as to entitle it to be considered as a separate branch of the cotton industry. The area devoted to the cultivation of cotton probably amounts in one year to about 36,736 acres, but as a considerable part of this land remains fallow every alternate year, the total quantity, *i.e.*, actually under cultivation and fallow would be about 60,000 acres. The extent of the area, even where the conditions of soil and climate are favourable, is limited, except in the Caspian littoral where the soil is moist and rain frequent, and irrigation not necessary to the water supply, although in many cases the labour available for cultivation has to be taken into account. The estimated annual yield of cotton per acre throughout the country is 500 lbs., and this is presumably seed cotton, which would be equal to 150 or 160 lbs. of ginned or lint cotton. The yearly produce of cotton is about 8,200 tons. On an average the cost of cultivation of 100 square yards is about fivepence for the season, and the production of one pound of unginned cotton would cost about one halfpenny. Each family cultivates its own plot—the landlord finding the water, which sometimes has to be conducted a long distance by subterranean aqueducts, called kanats, involving a large expenditure in their excavation. Rent is invariably paid in kind, and where the tenant provides his own seed and means of cultivation it generally amounts to half the produce; but where the landlord furnishes the seed, animals, and implements, he takes as much as two-thirds. The Government takes 10 per cent. of the value of the crop, and always in cash, which is sometimes paid by the landlord and at other times by the tenant. There is a peculiar kind of pile carpet called "Zaloo" much in vogue in Persia, which is made entirely of cotton, and used largely in mosques though very seldom in private dwellings. It has the reputation of being one of the most durable carpets manufactured in the country, and is cheaper than the woollen carpets. Another kind of carpet called "Ghilan" is indifferently made of cotton, a mixture of cotton and wool, and sometimes of pure wool. There are beautiful specimens of silk embroidery, both ancient and modern, which have a groundwork of very common kind of home-made cotton cloth.

GERMAN EGG TRADE.

Germany, next to Great Britain, is, according to inquiries which have recently been made by the United States Consul at Stuttgart, the largest consumer of eggs in Europe. By the statistics of 1890, 50,000,000 chickens were reported in the Empire, and it was estimated that 3,500,000,000 eggs were supplied from this source, besides which there was an import of 176,368,000 lbs., valued at £3,500,000. In 1896 there was an import of 196,209,400 lbs., valued at £4,000,000. Against this import we find, in 1890, an export of only 170,173,254 lbs., valued at £35,000. Eggs are usually imported in cases, weighing about 220 lbs., containing an average of 1,440 eggs each. It appears that the net importation, after deducting the small export, amounts to about 1,520,000,000 eggs. From the whole importation of about 187,391,000 lbs., about 88,184,000 lbs., equalling 720,000,000 eggs, come from Russia; Austria-Hungary furnishes about 83,774,800 lbs., or 680,000,000 eggs; Italy, 11,023,000 lbs., or 90,000,000 eggs; Holland, 2,204,600 lbs., equal to 18,000,000 eggs; and other countries, 1,984,140 lbs., equalling 15,000,000 eggs. Following these figures further, it would give a consumption of about 100 eggs a year for each inhabitant of the Empire. Consul Johnson says that the only reason he can discover why Germany does not produce sufficient eggs for her own consumption, and why she is obliged to pay from £3,500,000 to £4,000,000 a year for eggs imported from other countries, is the excessive dampness, causing a large mortality among young chickens, and the further fact that large districts are occupied by extensive estates. In all districts are to be found wholesale dealers in eggs, who buy up all small lots offered and pack and prepare them for the large markets. It is interesting to note the difference in weight in eggs imported. We find 1,000 Austrian eggs averaging 110 lbs.; the Russian eggs average 105 lbs., whereas the Italian eggs rise to 118 lbs. per 1,000, There being also an extensive importation of dressed and live fowls and feathers into the country, it is estimated that Germany pays yearly for fowls, and products therefrom, a sum considerably exceeding £5,000,000.

Obituary.

James Heywood, F.R.S.—Mr. James Heywood, F.R.S., who died on 18th inst., was a member of the Society of Arts of long standing, having been elected in 1858. He was a member of the Council from 1873 to 1876, and for some years took considerable interest in the work of the Society. He was the fifth son of Mr. Nathaniel Heywood, banker of Manchester, and was born on May 28th, 1810. He was educated at Trinity College, Cambridge, where he was a senior Optime in 1833; but he did not graduate B.A. till 1857, when the obligatory subscription to the Articles of the Church of England was abolished. He was an enthusiastic supporter of the Free Library movement, and for years found the funds for the support of a Free Library at Notting hill.

General Notes.

Imperial Institute.—A commercial Reading-room, open free to the general public, has been established at the Institute, in the hope that it may be specially useful to mercantile men, manufacturers, &c. either resident in, or visiting the Metropolis. A considerable number of commercial and technical publications (British, Indian, and Colonial and Foreign) can be read or consulted in the Reading-room. In addition, the Room will contain a collection of trade circulars, information in regard to shipping, transit by rail, &c. Maps of different portions of the Colonies are likewise exhibited, and many maps or charts included in the collection provided in the Map-room of the Institute may be consulted on application. Works connected with the Colonies and India (such as Diplomatic and Foreign Consular Reports, Directories, Year-books and Hand-books, Government Gazettes, Market Reports, Prices Current and Statistics, Parliamentary Papers and Blue-books, Statistical Registers, Weather Reports, &c.) are available to the public visiting the Reading-room, on filling up application forms.

Journal of the Society of Arts.

No 2,345. Vol. XLV.

FRIDAY, OCTOBER 29, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

STOCK PRIZE.

The Council of the Society of Arts, acting on the recommendation of the Department of Science and Art, have awarded the prize offered by the Society under the Stock Trus- for competition among students of the Schools of Art in the United Kingdom, for a design for architectural decoration, to—

Alfred Coumber, of New-cross School of Art, for his design for the decoration of a Turkish Bath.

Mr. Coumber's design, for which a silver medal was awarded in the National Competition, consists of five drawings:—1. Plan of the whole. 2. Elevation of a complete bay. 3. Sheets of details.

The prize consists of the Society's gold medal or a sum of £20.

Proceedings of the Society.

CANTOR LECTURES.

ALLOYS.

By Prof. Chandler Roberts-Austen, C.B., D.C.L., F.R.S.

Lectures II. and III.—Delivered March 22 and 29, 1897.

Lecture II. consisted mainly in the exhibition of the complicated appliances and apparatus employed in the measurement of the rates of diffusion of solid and molten metals in each other. As the results of these experiments have already formed the subject of the Bakerian Lecture[*] of the Royal Society for the year 1896, which was published in the "Philosophical Transactions," it is unnecessary to give more than a brief statement of the results. It is, however, necessary to do this in leading up to the subject of the third lecture of the present course.

The belief has long been prevalent that diffusion must take place against gravity when a denser metal is placed below a column of a lighter molten metal, and the results given in the Bakerian lecture showed that such diffusion does take place in molten metals just as is the case when salts diffuse in water, the curves representing the diffusion of molten metals and the diffusion of salts being of the same order. The continuation of the experiments with molten metals led to the recognition of the remarkable fact, which is probably of much industrial importance, that diffusion of metals can readily be measured not merely in molten but in *solid* metals. A history of the subject has been given in the Bakerian lecture (to which reference has just been made) and until the results of the experiments were published in that lecture, so far as I am aware, no attempt had been made to determine in units of diffusivity, the rate of the interdiffusion of solid metals. In dealing with the history of the views as to the possibility of diffusion in solid metals, a very interesting observation was made in 1820 by Faraday and Stodart,[*] who in the course of an investigation on the alloys of iron with other metals, note their failure to produce certain alloys by "cementation," but consider it "remarkable" in the case of platinum that it will unite with steel at a temperature at which the steel is not affected. This early recognition that alloys could be produced by cementation is very curious. It shows that Faraday and Stodart had observed a creeping molecular action occurring at a temperature below the fusing point of either platinum or carburised iron. They pointed out that solid steel and platinum, in the form of bundles of the mixed wires of these metals, may be welded together "with the same facility as could be done with iron or steel," and they showed that on etching the surface of the welded mass by an acid, "the iron appeared to be alloyed with the platinum." Their interest in this singular fact led them to promise some direct experiments on "this apparent alloy by cementation;" but, unfortunately, their intention does not appear to have been carried into effect. The matter is of much interest, and by the kindness of Dr. Harold L. Barnard, a relative of Professor Faraday, who has inherited

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" . Trans. Royal Soc.," vol. 187 1896) A., p. 383.

[*] "Quarterly Journal of Science," vol. 9, 1820, p. 319.

Stodart. Fig. 1 (*a*) shows the bands of iron and certain interesting specimens which were prepared in the laboratory of the Royal Institution, I have been allowed to make photographs of the polished surfaces of the actual alloy of steel and platinum obtained by Faraday and platinum under a magnification of only four diameters, the platinum being the darker and the steel the lighter constituent of the little mass. In Fig. 1 (*b*), under a magnification of 1,000 diameters the steel is the mottled and the platinum the striated portion, and there is a band apparently some ¼ in. wide, of lighter colour in the platinum at its junction with the iron, which clearly indicates that interpenetration of the two metals had been effected to a certain depth. It is true that for centuries the Japanese have prepared such banded alloys of copper and silver with gold for the purposes of art metal-work by methods which I have already described in the *Journal* of this Society,[*] but the specimen of the steel-platinum alloy I have photographed probably represents the first effort to study the alloying by cementation of two solid metals.

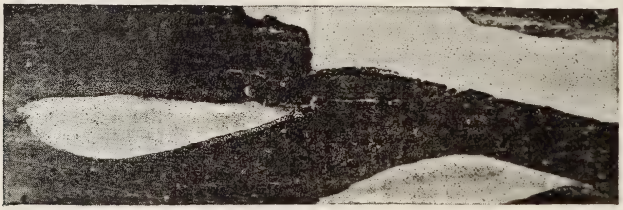

FIG. 1*a*.

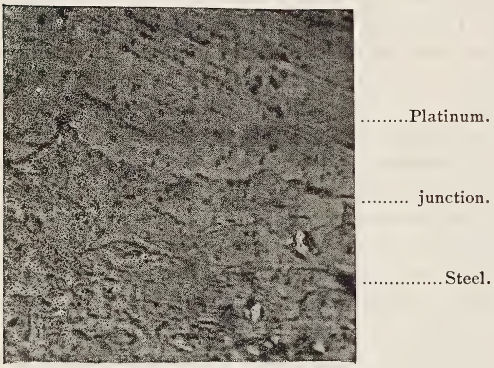

FIG. 1*b*.

The experiment by Faraday and Stodart enables us to approach the consideration of the question of the analogy of carburised iron to ordinary saline solutions. It is necessary to bear in mind that there is abundant evidence of the penetration of iron by carbon, even in its diamond form. The diamond penetrates iron, and, moreover, the action is reciprocal, for at a temperature of 1100° the vapour of iron penetrates the diamond.[*] As yet, however, the rate at which carbon will penetrate iron at any given temperature demands investigation and measurement; some data are, however, already available. The process of cementation has been exhaustively studied by Mannesmann,[†] and reference will be found in the Bakerian lecture to the work of Colson.[‡] As a contribution to the history of the subject the following curve (Fig. 2) taken from a paper I communicated[§] to the Iron and Steel Institute, in 1896, may be useful. The coordinates of the curve are respectively *distance* to which the carbon has penetrated a mass of iron, and the *amount* of carbon which has so penetrated. If this curve be compared with those which represent either the diffusion of common salt in water, or the diffusion of gold or platinum in lead (*see* Bakerian lecture), it will

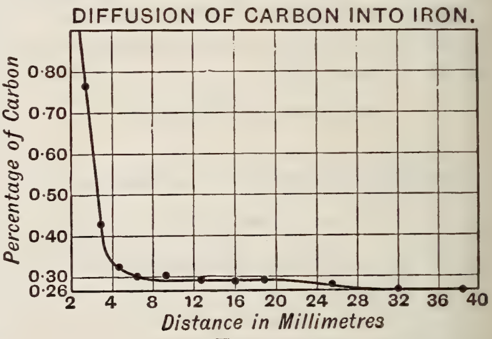

FIG. 2.

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[*] *Journal of the Society of Arts*, June 13, 1890.

[*] Osmond, "Comptes Rendus," March 16, 1891.

[†] Verhandlungen des Vereins zur Beförderung des Gewerbgleisses, 1879, vol. lviii., p. 31.

[‡] "Comptes Rendus," vol. xciii., 1881, p. 1074; and vol. xciv., 1882, p. 26.

[§] "Journal Iron and Steel Inst.," No. 1, 1896.

be found that the curve for the carburisation of iron is a true diffusion curve, and this points to the *solubility* of carbon in the iron.

It will now be well to indicate the nature of the evidence afforded by the microscope as to the mode of existence of the carbon in the iron under varying conditions of thermal treatment.

By the kindness of my friend, M. Osmond, I am able to pass to actual photographs of micro-sections of different varieties of steel which he has been so good as to prepare for me. The degree of carburisation of the steel varies from 0·45 to 1·60 per cent. of carbon, and the thermal treatment of the steel was in all cases different, and the nature of the treatment of each specimen will be indicated presently. The method of preparing such micro-photographs is described in full detail in a paper by M. Osmond,* to which the student must refer, for the preparation and interpretation of such sections demand much experience, and do not admit of brief explanation. It is necessary to state at the outset that, in accordance with a suggestion made by Professor Howe, mineralogical names have been given to the various constituents of steel in order to facilitate their identification. For micrographic purposes, steel is viewed as if it were a rock with various minerals distributed through it. Thus iron free from carbon is called "Ferrite," and is left white and brilliant when the polished specimen is treated either with a solution of iodine or an infusion of liquorice. Strong nitric acid also does not attack it, but the use of this reagent is not to be recommended to beginners in micrographic investigation.

"Cementite," another constituent of steel, is a carbide which corresponds to the formula Fe_3C. It remains bright after the polished section of steel is attacked by iodine solution. It is hard, and stands in relief when the steel is polished with the finest rouge on parchment placed on a soft support, such as wood. Free cementite does not occur in low carbon steels. "Pearlite" is an intimate mixture of ferrite and cementite; it is a very characteristic constituent of steel which has been slowly cooled from a high temperature, and if the steel contains about 0·9 per cent. of carbon the whole mass will mainly consist of pearlite. It may be either lamellar or granular in structure, and is, in fact, the old "pearly constituent" which was long ago detected by Sorby in steel. It may be coloured dark by iodine solution, and its presence is best revealed when the steel is polished in relief by the method which has just been indicated, and treated with a filtered infusion of liquorice root in cold water. It consists of lamellæ which are alternately hard and soft. "Sorbite" is a constituent which is tinted by either an infusion of liquorice or by iodine, while cementite is not. It is a transition from and passes into pearlite. "Troostite" is a transition from between soft iron and steel which has been hardened by quenching, but as in the case of sorbite, its nature cannot at present be well defined by micrographic reactions. "Martensite" is the very hard constituent of hardened steel. It appears like a system of interlacing crystalline fibres, and it may readily be coloured by a tincture of iodine. There is yet another constituent, "Austenite," found by M. Osmond in high carbon steel which has been quenched from a high temperature in iced brine. It appears to be non-magnetic.*

As M. Osmond has pointed out these two reagents, a solution of iodine or an infusion of liquorice, enable the constituents of steel to be divided into two groups, in both of which, however, martensite finds a place. These groups are (*a*) not coloured by infusion of liquorice: ferrite, cementite, and martensite; (*b*) coloured by liquorice: martensite, troostite, or sorbite. Martensite, which only assumes a yellowish tinge, may be recognised by its crystalline form. A dilute solution of iodine will, moreover, by acting on a polished surface, enable the constituents to be again divided. Those which are not coloured by iodine are ferrite or cementite, while those which are coloured are sorbite, troostite, or martensite. It must not be thought that these brief indications will render it unnecessary to refer to M. Osmond's memoir for fuller details, but the information already given will probably be sufficient to make the description of the following illustrations clear. All the micro-sections, of which the following photographs are given, have been magnified 1,000 diameters. With one exception they have all been prepared by polishing in relief and treatment with the infusion of liquorice. Figs. 3, 4, 5, 6 represent steel which contains 0·45 per cent. of carbon. Fig. 3 represents this variety of steel which has been forged and annealed by slow cooling from a temperature of 750°. It shows ferrite and pearlite, certain portions of the pearlite passing into sorbite. There are also a few grains of entangled slag. Fig. 4 shows the same variety of steel after it has been heated to 730° and quenched immediately in water. It contains troostite, ferrite, and martensite. Fig. 5 shows the structure produced by heating the same steel to 825°, allowing it to cool slowly from 825° to 720°, and then quenching it in water. The section after such treatment consists of martensite. Last, as regards this variety of steel, in Fig. 6 the heating and quenching were effected at the same temperatures as in the case of Fig. 5, but the steel was subsequently "tempered," and the micro-section shows a confused structure without indicating the presence of definite constituents. Fig. 7 was taken from a micro-section of steel which contains 1·24 to 1·5 per cent. of carbon, and it consists both of pearlite, the striated portion, and of the cementite, in which the striæ of the pearlite have, as it were, run together, forming a comparatively thick band, the steel having been cooled with sufficient slowness from a high temperature.

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* "Bull. de la Soc. d'Enc.," May, 1895.

* "Comptes Rendus," vol. cxxi., 1895, p. 684.

Fig. 8 represents steel containing from 1·50 to 1·60 per cent. of carbon, such a variety of steel, in fact, as would be produced by the ordinary operation of cementation. The material has been heated to 1,000° and quenched in iced water. It contains austenite and possibly some martensite. The austenite is the lighter constituent; the darker is probably martensite, but the nature of this constituent is somewhat uncertain.

It will therefore, I trust, be evident that photo-micrography affords most precious information both as to the constitution of steel and as to the complication of relations which may subsist between carbon and iron.

In order to make any discussion of these relations possible, it is necessary to bear in mind the dominant fact so beautifully developed by M. Osmond that, as carburised iron cools down from a high temperature, there are several points of arrest in the cooling which mark important and critical changes. In round numbers there is one such point at 850° C. called by M. Osmond A.r.3; there is another at 750° C. called A.r.2; and yet another at 650° C. called A.r.1. The changes which occur respectively at 850° C. and 750° C. can, as I showed some years ago, also be detected in the purest iron yet produced, and this fact has recently been confirmed by Messrs. Hicks and O'Shea.* It is claimed, therefore, that these points represent allotropic changes in the iron, a view which receives strong support from the fact that the magnetic properties of iron change distinctly and more or less sharply at 750° C. (A.r.2.).

Let it be assumed, as has already been suggested above, that the diffusion of carbon in iron is analogous to the diffusion of common salt in water. The iron or "ferrite," corresponds to the water, but the diffusing chloride of sodium is not represented by carbon, but by a compound of carbon and iron, Fe_3C., the existence of which, in steel, can be abundantly demonstrated, and to this compound the name "cementite" is given. If a hot solution of common salt were allowed to cool, salt would fall out of solution, and in the same way if a hot solution of cementite, Fe_3C, in iron be allowed to cool, Fe_3C will fall out of solution, and, in highly carburised steels, segregated or free cementite will "fall out," just as the salt did from the water. Turn to photograph No. 1 and it will be seen that it contains carburised kernels of pearlite; it is a variety of steel low in carbon, there is only sufficient dissolved carbide, Fe_3C, to separate out in patches as the mass cools. In steel with more carbon, such as is shown in Fig. 7, the carbide separates out and pervades one part of the mass as pearlite, together in another part of the mass with some segregated "cementite" which, as has been already stated, constitutes a broad band across the specimen.

What then is "martensite?" According to M. Osmond, it appears to be formed during the heating of a mass of carburised iron by a true internal "cementation" of the "ferrite" or free iron of the mass, an operation which takes time and is proportionately longer the lower the temperature is. If a mass of carburised iron (within the range of carburisation, that is, which constitutes steel) be rapidly cooled from a high temperature by quenching, the carbon remains in the form of martensite, as in No. 5, and the steel is "hard." If the cooling is rapidly effected by quenching small samples of steel in water mixed with ice, the cooled metal should reveal a structure which nearly approaches that possessed by the metal while it is hot; and M. Osmond has shown that the proportion of segregated cementite varies with the temperature of quenching. If this temperature exceeds 1,000° C., a percentage of dissolved carbon amounting to 1·60 per cent. may be reached without the isolation of cementite. At this stage a new constituent appears—the one M. Osmond has been so good as to connect with my name; and the most salient of the properties of "Austenite," so far as it is possible to ascer-

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* Commemoration Volume, University College, Sheffield 1897, p. 52.

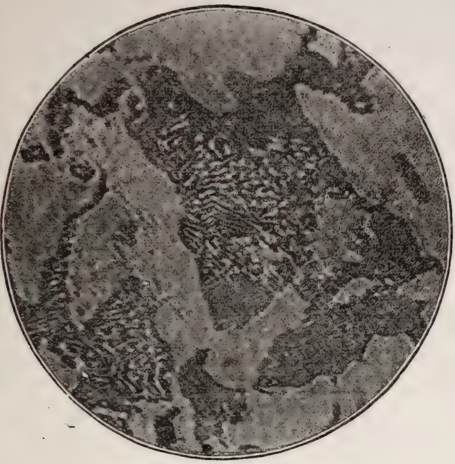

FIG. 3.

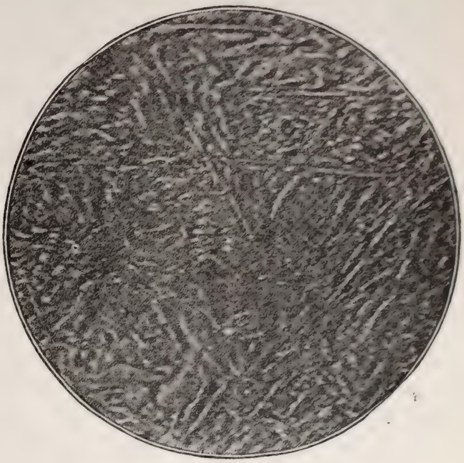

FIG. 6.

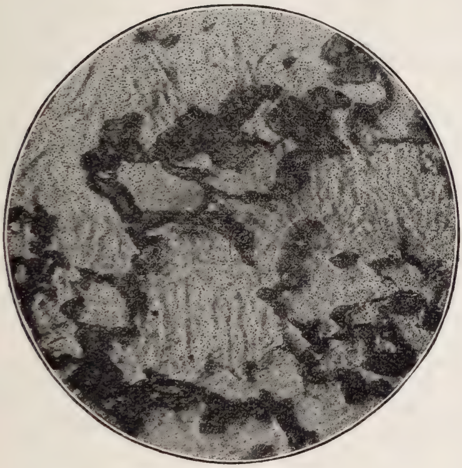

FIG. 4.

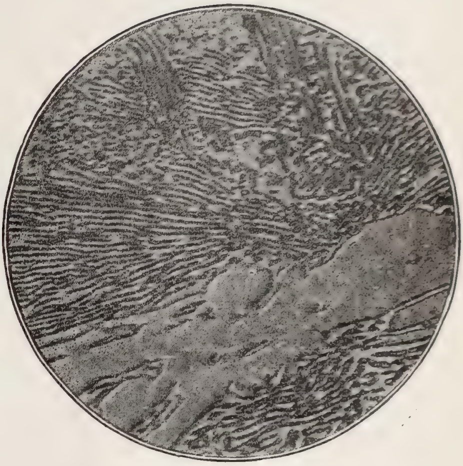

FIG. 7.

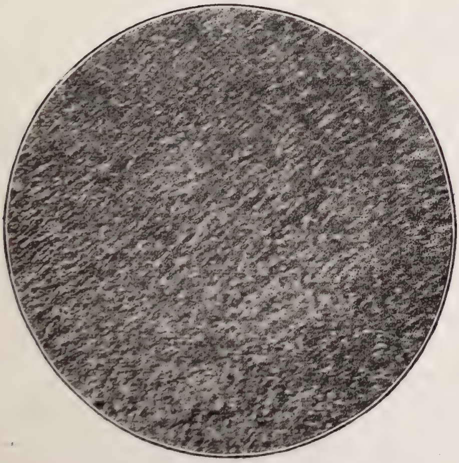

FIG. 5.

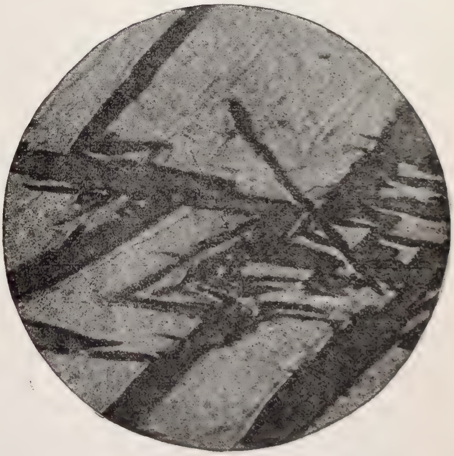

FIG. 8.

tain them, is that of being scratched by a darning needle or by apatite. It is a mixture closely resembling the properties of steel with 12-13 per cent. of manganese and steel with 25 per cent. of nickel. When, however, the per-centage of carbon exceeds 1·6 per cent., cementite re-appears.

It will now be possible to trace the relation between the freezing point curve of the carbon-iron series and that of certain alloys. Usually when two substances which form neither definite compounds nor isomorphous mixtures are soluble in each other, it is known that their curves of fusibility or of solubility, for they are practically the same thing, in most cases is composed of two branches; one of these branches corresponds to the deposition in a solid state of one of the constituent substances of the mass; the other branch corresponds to a deposit of the second substance. Let me remind you of the case of the lead-tin series (see Fig. 5 of last lecture) which belongs to the class of simple solutions. At a temperature near the melting point of lead an alloy of lead and tin containing 50 per cent. of each metal would be entirely fluid, and the two metals would be in mutual solution. If the alloy were to cool down to 220° solid lead would begin to crystallise out; the solid lead, the analogue of ice in a saline solution, can exist in contact with the fluid so long as the temperature is kept constant. As the temperature falls, more and more lead crystallises out until at 180° the residue, which by this time contains nearly 70 per cent. of tin, solidifies as a whole, and this alloy is the *eutectic* alloy. In the curve, Fig. 9, there are the two branches, A B, B D, and the eutectic, *a c*. In order to obtain this curve I prepared a series of carburised irons as free as it was convenient to make them from silicon and manganese, and have taken freezing point curves of them by the autographic recorder, precisely as if it were merely a question of the solidification of an ordinary series of metallic alloys. Thus the iron containing, say, 3 per cent. of carbon, was found to have three freezing points, which occurred respectively at 1,200°, 1,120°, and 680°. Putting all the results for the entire series of carburised irons in a curve and adding some results obtained by M. Osmond (for he has been engaged in the investigation of the subject since 1888 *) the appended diagram, Fig. 9, will be the result. It should be remembered that points in the same vertical line represent points of arrest in the cooling of a single carbon-iron alloy.

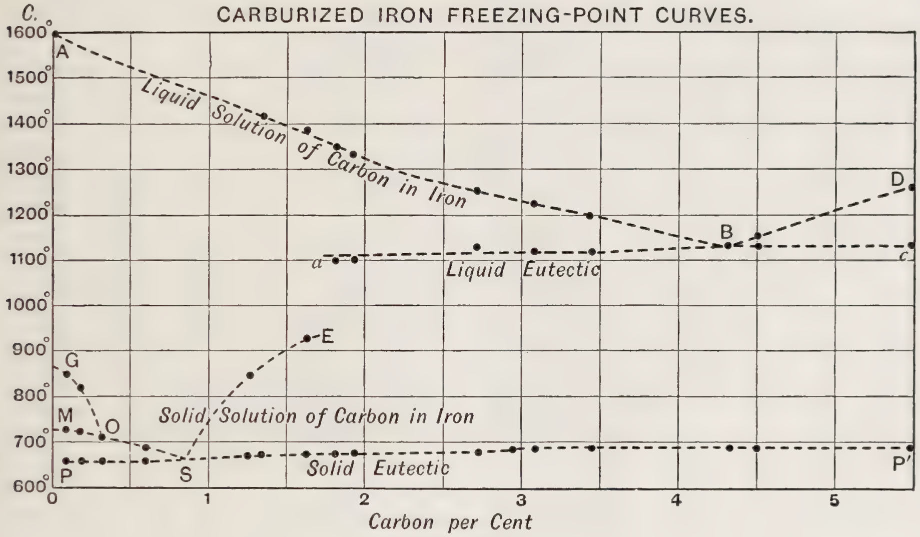

FIG. 9.

I should add that my assistant, Mr. Stansfield,† in a discussion of a paper read at the Institution of Civil Engineers in 1895, pointed to the analogy of carbon-irons to cryohydrates, and as Guthrie showed the cryohydrates of salts are analogous to alloys.

The line A B represents iron containing dissolved carbon, and the line B D indicates that free carbon in the graphitic form separated out. The line *a* B *c* should therefore correspond to a eutectic of liquid iron and carbon. As Fe_3C

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* "Ann. des Mines," vol. xiv. (1888), pp. 39 and 59.

† "Proc. Inst. Civil Eng.," vol. cxxiii. (1895), p. 260.

dissociates at a temperature of 1,100°, it can only exist under the osmotic pressure of dissolved carbon, and, therefore, cannot separate out above the line *a c*, but must be formed at or below this temperature in the cooling mass of iron.

What then is the line P P′? It is clearly the eutectic of a solid solution.

What then is hardened steel? According to M. H. le Chatelier*, it is a solution of a carbide of iron, Fe_3C, and of a variety of iron. This solution is like the glasses in a state of supersaturation or surfusion, but, unlike the glasses, quenched (hardened) steel is not amorphous but crystalline, and its structure resembles that of the isomorphous crystalline mixtures. It is this possibility of the existence of solid solutions that we are now confronted with, and the experiments on the diffusion of solid metals derive much interest from the light they throw on the theory of the hardening of steel.

It will be seen that there are branches in the left-hand corner of the diagram which remain to be explained. There is a branch, GO, which begins in carbon-less-iron at 860° A.r.3. It corresponds to the beginning of the aggregation of the ferrite, that is, of the iron itself in the solid mass. It must be, and is, according to the theory I have so long advocated, a true allotropic change; it is the change of γ iron into the β form in steels which are not saturated with Fe_3C. It will be seen that there is a point corresponding to about 0·9 per cent. of carbon; this, according to M. Osmond, is the point at which a iron and the carbide Fe_3C are simultaneously deposited at a constant temperature. It is the point at which γ iron and Fe_3C are mutually saturated, and "at this point the phenomena which occur are exactly comparable with the solidification of eutectic alloys. The line PP′. then represents the change at 650° of iron containing about 0·9 per cent. of carbon from a solid solution (martensite) to a mechanical mixture of ferrite and cementite, known as pearlite. This occurs through all the range of carburised irons, from the mild steels to the cast irons. To the right of the point S, as carburised iron cools down cementite separates out, and about 0·9 per cent. of carbon still remains in solid solution in iron. It must be remembered that it is soluble in one of the allotropic modifications of solid iron. At 650° the iron, during slow cooling, undergoes allotropic modification, and is converted into a form of solid iron which will not dissolve cementite.

There is, however, one other point of analogy between carburised iron and saline solutions, and it is as follows. When Eggert's test is applied to steel it is well known that a certain portion of the carbon known to be present in the steel is not indicated by the test; it is, in fact, known as "missing carbon," and it is reasonable to conclude that the carbide, Fe_3C, when dissolved, that is to say as martensite, becomes in part dissociated into its "ions," which remain free together with molecules which are intact.*

From this M. Osmond concludes that the fraction of carbon exists as Fe_3C, in solution, and in annealed steels it forms the constituent called sorbite.

The line, M O, appears to be another solid eutectic; it corresponds to the 750° A.r.2 change in the iron, and requires further investigation.

The fact that there is solution of carbon in iron is therefore clearly demonstrated, and the question arises, may it not, under certain conditions, be released from solution in the diamond form and not in the graphitic? Moissan† has enabled us to answer this question, and has shown that diamonds may be readily produced. Carburised iron expands on solidification, and a mass of fused iron will become solid at its surface and will contract; but when, in turn, the still fluid mass in the interior cools it expands against the solid crust and consequently solidifies under great pressure. Dissolve such a mass of carburised iron in nitric acid to which potassic chlorate has been added: treat the residue with caustic potash, submit it to the prolonged attack of hydroflouric acid then to boiling sulphuric acid, and finally fuse it with potash to remove any traces of carbide of silicon, and carbon is left—but in the form of diamonds.

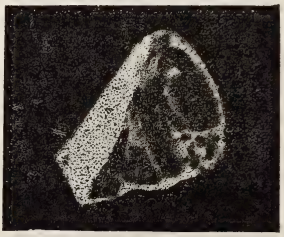

FIG. 10.

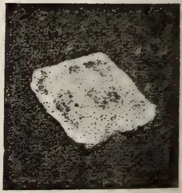

FIG. 11.

The enlarged photograph, Figs. 10 and 11, shows specimens which I have prepared by

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* "Revue Général des Sciences," January, 1897, p. 22.

* Hogg, "Journ. Iron and Steel Inst." (1896), Part II.

† "Comptes Rendus," vol. cxviii, 1894, p. 324.

Moissan's method. They sunk in methylenic iodide, and other specimens obtained at the same time, which were identical with these, sustained all the tests for diamonds.[*]

[Specimens of diamonds so prepared were then thrown on the screen. As regards their actual size they neither of them were more than half a millimetre across.]

It will, I trust, be evident from the foregoing remarks, that there is the closest analogy between carburised iron and ordinary metallic alloys, and that complicated movements may take place in solids.

Miscellaneous.

MONTREAL POWER WORKS.

On September 27th last, the Lachine Rapids Hydraulic and Land Company's Works were opened by the Mayor of Montreal. For many years the idea of utilising the Lachine Rapids as a means of obtaining light and power for Montreal has been talked of. The company began the construction of an electricity producing plant on October 2nd, 1895. The engineers estimated that there was at least 27 feet of water in the rapids, and allowing that the river in Laprairie Bay would rise during the winter twelve feet, there would still leave fifteen feet of fall available for power purposes. They, therefore, placed the power-house in a position that would give them this fall, and decided to entirely remove the reef. They also constructed a guard pier, some 1,200 feet long from the power-house running down stream, the object being to prevent débris and ice from getting in and blocking up the wheel pit.

The number of men regularly employed on the works has averaged about 7,500.

The power-house is situated some distance below the rapids. Its foundation is the dam and the superstructure contains the turbine wheels, the shafting and the generators. The length of the building is 1,000 feet. The dam or foundation is constructed of huge blocks of grey stone, resting deep down upon the bed rock of the St. Lawrence. The parts of the superstructure containing the water-power machinery are inclosed by corrugated steel plating lined with spruce. Equally distant along the dam and connected with each other by the steel wheel sheds, are the three dynamo houses of brick with slate floors bedded in concrete. These brick dynamo houses are larger than the connecting portions of the building projecting to both sides of the dam. The frame of the whole structure is of steel.

At the end of the dam and standing upon the shore is a square brick tower containing the offices of the operating staff. Out from the second storey of this tower come the insulated wires that convey the electric current to the city limits, at which point the wires pass into the underground conduits to the distributing stations. At the river end of the power-house and its main dam is a cross dam extending up stream and becoming the head-race and also reaching down stream and separating the tail-race from the river. The head-race is 4,000 feet long and 1,000 feet wide.

FISHERIES OF ICELAND.

Next in importance to the rearing of live stock in Iceland comes fishing, which affords a means of livelihood to 18 per cent. of the population who make their living entirely thereby, besides which, a large proportion of the farming population, take a share in the fishing in its principal seasons. From a commercial point of view, fishing plays a much more important part than farming, as 62 per cent. of the average annual value of the total exports of Iceland are the products of the fisheries, while the products of farming only amount to 34 per cent. Consul Paterson, of Reykjavik, says that the principal fishery is that for cod and haddock, which is, for the most part, carried on in open boats manned, on an average, by six men each, who fish by means of hand lines, long lines, and nets. These small boats cannot, of course, go far from land ; bad weather or a rough sea keeps them on shore. They can carry little provisions, and provide no shelter to their crews, who, in consequence, can only remain at sea for a few hours at a time. In spite of all these disadvantages, the open boats still carry on by far the greater part of the cod fishery, though the number of smacks or small decked vessels used is now very considerable, and is increasing every year. The open boats are much more profitable than the smacks when fish is plentiful on the coasts, but when fish is scarce, the smacks can shift their position round the island until they find the richest bank, while the open boats are confined to the neighbourhood of their own immediate district. Shark fishing is carried on to some extent, chiefly on the north and west coasts, and mostly by means of decked vessels, though open boats are also used. Herring fishery is an important industry in the fjords of the east coast, where it is pursued by means of seine or drag nets on the Norwegian system. Halibut and other flat fish abound on the coasts of Iceland, but though largely used in the country itself, these fish were not exported to any appreciable extent until ten or twelve years ago, when a few American schooners began fishing for halibut on the west coast, taking their catch home in salt. A few years later British line fishing steamers began coming up to the east and south coasts, where they catch mainly halibut, which is carried home either in ice or alive in welled vessels. Three or four years ago British steam trawlers began to fish on the east and south coasts for halibut and plaice. The Icelanders have always complained that foreign vessels fished unlawfully within Icelandic territorial waters, and they are particularly opposed to the presence of trawlers on their coasts. In consequence, a special law was enacted in 1894, entirely prohibiting trawling in territorial waters, under heavy penalties, and even imposing fines on vessels lying in or passing through territorial waters with trawls on board, although not engaged in fishing. This law is still in force, and it is certainly not advisable for vessels with trawls on board to enter Icelandic ports, unless in distress, or to pass within three miles of the land. The most important fishing district in Iceland is the southern part of Faxe Bay, on whose shores Reykjavik lies. More than one-third of all the fish exported from Iceland comes from this district, and its inhabitants, who number about one-seventh of the total population of Iceland, live for the most part by fishing. Faxe Bay is of considerable extent, being about 60 miles wide by 40 miles long, but is shallow in proportion to its size, and in the southern portion, where the fishing banks lie, a very large part of the bottom, especially near the coast, is unsuitable for fishing, owing to the beds of lava which run out from the land and spread over vast tracts of the bottom, leaving only the comparatively limited sand and mud banks and channels between them available for fishing purposes. In 1895, a few British steam trawlers entered Faxe Bay, which foreign fishing vessels had not frequented hitherto, and as they found halibut and plaice plentiful there, a much larger number came last year, when there are said to have been over 20 trawlers in the bay at once, and this year (1897) it is expected that they will be much more numerous. This threatens to be a very serious matter for the native fishermen, as the experience of last year has shown that the fishing banks of Faxe Bay are too limited in extent to afford room both for the boat fishers and the trawlers, and the former being the weaker must yield. As the greater part of the fishing banks in Faxe Bay lie outside the three mile limit, it is impossible for the native fishermen to confine themselves within territorial waters which the trawlers may not enter. To do this would be to virtually abandon fishing entirely, and as fishing is practically the sole means of livelihood of the inhabitants, this would involve their utter ruin and the depopulation of the district.

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[*] Oct. 1897. Consult also for diamonds in steel a paper by Leon Franck, "Stahl und Eisen," vol. 16, 585.

THE LOWER CONGO AND ITS PEOPLE.

From Banana to Boma the country is flat, and in the rainy season very swampy; the banks are thickly wooded, but there is hardly any timber fit for export. Running east and west, and starting some twenty miles north of Banana there is a range of foot hills which extend to and beyond Stanley Pool to Bolobo, increasing in height and width as they approach the Pool. This range is a continuation of the system which runs the entire length of the west and south-west coasts of Africa. Mr. R. Dorzey Mohun, who was appointed by the United States Government to inquire into the condition of the Congo Free State, says that the land, in his opinion, is not suitable for agriculture, except on a small section near Banana Point. The only products of the soil shipped to Europe are palm kernels, palm oil, and pea nuts: and these are the only articles which are traded for by factories in the Lower Congo valley. A few vegetables are grown in the gardens attached to each factory, but the soil has to be worked over and over again and watered two or three times a day in order to make them grow. No domestic animals exist among the natives, except a few goats and sheep, which command high prices. All the beeves, which are consumed by the railroad company's *employés* are brought from Benguela and Mosamedes (on the south-west coast in Portuguese territory), by the Compagnie du Produit du Congo, which has established a large cattle ranche on the island of Mateba, below Boma. There are about 3,000 head there, and this herd is increasing. The tsetse fly does not exist, and the land is such that it could, no doubt, be made to yield profitably without an enormous sum being expended for irrigation. It is possible that on the hills to the north of Banana coffee might be grown advantageously, and cocoa on the lowlands; but the experiment has not yet been tried. The articles used for trade with the natives are red bandana handkerchiefs, gin, cloth, beads, machetes, old silk hats, coloured parasols, cheap knives, flintlock muskets, powder, brass rods, crockery ware, tinware, old uniform coats, rum and watches. All these articles are specially made for the trade, and the standard of value is a piece of handkerchief, 24 feet long and 3 feet broad, and valued at about 2s. 6d. When the trader buys produce, he gives out cards to the natives which are good each for a piece of handkerchief, and when the caravan has been bought out the natives come to the store and hand in their cards, where they can select what they want to the value of the cards held. As a rule they will not touch money, regarding it as useless; and this, of course, is a great advantage to the trader, who makes large profits in exchange for handkerchiefs, which probably cost him, landed on the Congo, duty paid, about tenpence each. The quantity of gin which comes into the Congo is enormous, but none of this ever reaches the interior of the State as its importation has been prohibited. Very little ivory is bought in the Lower Congo, and this comes from a distance of not more than 100 miles north, south or east, of Boma and Matadi. The large quantities of ivory which are being shipped from the Lower Congo come entirely from the Upper Congo. These shipments are increasing year by year, and Mr. Mohun gives it as his opinion that there is ivory enough in Central Africa to last at least another century. The natives of the Lower Congo belong to the Fiote tribe, but there is absolutely no king or chief among them. There are some so-called kings; but they have no authority whatever and are only kings because they call themselves so, on account of having a few more rods, bales of cloth, or boxes of gin than their neighbours. Each village is independent of the other and has it own head man, but no one recognises the right of any one as their supreme ruler. Fetichism is largely practised, and there is much quiet poisoning going on in the different villages by fetish doctors, but the hanging of several of these poisoners by the State has had a most salutary effect upon the remainder. They practice no religion whatever; they worship no idols, no fire, sun, or moon, or stars. If they wish to accomplish something, they propitiate a wooden fetich by hanging beads and gin bottles about its neck and murmuring some jargon to it. If something is stolen from them they drive a nail into the fetich, perfectly convinced that in this manner they will succeed in killing the thief. Near Boma there is a native school of medicine, and the people who attend it for study are called "Imkimbas." During their term of study they must keep themselves whitewashed or painted white from head to foot. The natives are not particularly savage or vicious towards the white men. Only once in a while has the State found it necessary to send expeditions to enforce the laws. They have no arms of their own manufacture, and for hunting and war purposes use the trade flintlock musket. When a native dies and is buried, if he is a rich man, his body is wrapped in hundreds of yards of cloth, and many pounds of gunpowder are fired over his grave, which has been covered on the top with empty gin bottles, demijohns, basins, and pitchers; at the head a large red, blue, and white umbrella is stuck in the ground and hoisted. At night his friends and family indulge in a dance and drunken orgie. Their hair is usually dressed in some fantastic fashion; on their legs and arms they usually wear large brass rings, and around their necks a necklace of beads or tin tags from packages of tobacco. Their only clothing consists of a breech clout, or piece of cloth tied round their loins; no head covering whatever. Their food consists principally of palm nuts, palm kernels, manioc, and bananas; also rats, chickens, and locusts. They are not a particularly strong or healthy people, their only strength lying in their legs; and it is very rare to meet one who has reached the age of 50 years, although many look a hundred years old. A great number die of pulmonary complaints.

ITALIAN MINING INDUSTRY.

In mineral wealth Italy is a poor country, though it is believed by some that its resources in this respect have been under-estimated by geologists, and that closer attention will reveal riches hitherto neglected. The most important mineral district for compactness and variety of valuable production is that in south-western Sardinia, of which Iglesias is the centre. In Sicily the sulphur mines are famous, and there is a considerable mining industry in the Alps, particularly in the northern portions of the provinces of Brescia and Bergamo. The Apennines are remarkably poor in minerals, and though in the northern half there are a few good mines, south of Rome there is practically nothing. According to a recent report of H.M. Commercial Attaché at Rome, coal, the supply of which is so important for the encouragement of mineral industry, is only found in small quantities, and almost exclusively in the form of lignite. Tuscany has practically the monopoly of the coal production, the output of the small mines in other parts of the country, with the exception of one of some importance in the province of Brugia, being trifling. The total annual average production during the last few years has fallen short of 300,000 tons, and there is a marked tendency to decrease, notwithstanding the steadiness of consumption shown by the large quantities imported. The number of hands employed in coal mines in 1895 was 2,361, and from the official statistics it would appear that the average quantity of coal mined per working head per annum was 129 tons. It is said that some of the abandoned mines at the foot of the Tyrolese Alps conld be worked at a profit if the necessary capital were supplied for the introduction of proper pumping and winding machinery. The production of iron ore amounted in 1895 to a little over 200,000 tons, and throughout Italy there are some 1,700 hands employed in its extraction. By far the most important iron mines are those in the island of Elba, where the iron is of very good quality, and the output nearly seven-eighths of the total for the whole kingdom. The Elba mines belong to the Government, which leases them out for working by private enterprise. The remaining iron mines of any importance are scattered in the valleys at the foot of the Alps, the most important being those in the provinces of Brescia and Bergamo. There were formerly many blast furnaces for making charcoal iron in the valleys at the foot of the Alps; but though the iron produced was of excellent quality, the quantity was never large, and the destruction of forests has led to the abandonment of a good many works, the operation of which is traced back to the time of the Romans. As regards value of annual production, sulphur is the most important mineral worked in Italy. The annual average output during the last three years has been about 400,000 tons; the number of workmen employed in sulphur mining in 1895 is stated to have been 27,000, and the value of the production is given as £953,000. About seven-eighths of the total quantity of sulphur produced in Italy is mined in Sicily, in the central and southern provinces of Caltanisetta, Girgenti, and Catania, with a comparatively small quantity in the province of Palermo. Some sulphur is also found in the Apennines in the provinces of Ancona, Forli, and Pesaro, and at Avellino in the Campania; but the total production in 1895 in these districts was but little over 19,000 tons, which was consumed in the country for the protection of vines. Next to sulphur, zinc is by far the most important product of Italian mines. The quantity mined in 1895 was about 121,000 tons, valued at £290,000, and of this upwards of 97,000 tons were produced in the province of Sassari, both in the island of Sardinia. On the continent the most important production was about 15,000 tons, in the province of Bergamo, and minor quantities were found in the provinces of Brescia and Belluno. The production of lead ore in 1895 was about 30,000 tons, valued at £153,000. About 95 per cent. of the total comes from the mines at Iglesias, the remainder being produced in small quantities at different mines scattered over the north of the continent, the most important of which is in the province of Brescia. The production of copper has increased since 1890. In 1895 over 83,000 tons of ore were mined, valued at about £69,000, and the number of hands employed in copper mining is given as 1,260. The most important mines are in the province of Grosseto, in Tuscany, and there are mines at Sestri Levante, near Genoa, which yielded about 12,500 tons. In Tuscany there are four quicksilver mines working, which are said to be very profitable. The production of these mines was about 19,000 tons in 1893, about 15,000 tons in 1894, and about 11,000 tons in 1895. The average annual value of the ore in the last two years was estimated at about £31,400, and the number of workmen employed in the mines in 1895 was 501. About 870 tons of silver ore were extracted from the Iglesias mines in 1895, and small quantities in combination with lead are found in other parts of the country. The value of the silver ore produced in 1895 was estimated at about £24,200, but it has been steadily declining, having been £65,000 in 1892. The number of hands employed in silver mining is given as 700 in 1895. In the western section of the Alps, in the province of Novara, there are mines producing gold. The most important of these are the auriferous pyrites mines of Battigio and Pestarena, the latter worked by an English company, while another English company is about to re-open some mines on the Italian shores of Lake Lugano. The prrduction of gold appears to be increasing, but as yet the quantity produced is small, the average value of the yield in the years 1893, 1894, and 1895 having been only a trifle over £25,000. There are asphalt mines in Sicily, in the province of Syracuse, and smaller quantities of the mineral and also bitumen are found in some parts of the continent, and notably in the province of Chieti in the Abruzzi, where several mines are now being worked. The total production of asphalt, mineral wax, and bitumen in 1895 was about 47,000 tons, and of this total over 36,000 tons were produced at the Ragusa mines in the province of Syracuse. The chief mines at Ragusa are worked by the Limmer and Val de Travers Companies. The asphalt is said to be of very good quality, and about 30,000 tons are exported annually, the bulk going to Germany. The borax mines in the provinces of Pisa and Grosseto, in Tuscany, are of importance on account of the value of the product. The average quantity of boracic acid annually obtained in the last few years has been about 2,800 tons, and the value of the production in 1895 was estimated at about £38,500. Petroleum is found in the province of Piacenza, in Emilia, and small quantities also in the province of Parma and in the Abruzzi. The production has lately increased, and was greatest in 1895, amounting to nearly 3,600 tons in that year. Nearly the whole quantity is obtained from the workings in the province of Piacenza. A very large quantity of salt is produced in Italy, but the great bulk comes from marine salt pans. Rock salt exists in Sicily and Calabria, but is little worked, and the quantity obtained from salt springs is only about 11,300 tons per annum. There are two salt springs, one in the province of Pisa, which produces over 10,700 tons annually, and the other in the province of Parma. Of other minerals worked in Italy the principal are manganese, antimony, nickel, cobalt, alum, and graphite; but the production of all these is for the present comparatively insignificant, and they may be passed over without further comment.

General Notes.

FRENCH BICYCLE TAX.—The total yield of the bicycle tax in France for 1896 was 3,272,340 francs. The total number of bicycles taxed was 329,816, as against 256,084 in 1895, and 203,026 in 1894.

SUEZ CANAL.—The total number of vessels of all nationalities that passed through the canal during 1896 was 3,409 vessels, with a net tonnage of 8,560,283 tons. The number of British vessels was 2,162, with a net tonnage of 5,817,768 tons.

POPULATION OF BELGIUM.—The population of Belgium is increasing year by year, and according to recent official returns, some of the Belgian towns during the last hundred years have trebled, while others have quadrupled their population. In 95 years the inhabitants of the country have increased from 3,000,000 to 6,000,000, or 100 per cent. Brussels shows a growth of from 66,000 to 187,000, or 183 per cent.; Antwerp from 53,000 to 257,000, or 383 per cent.; Ghent, 55,000 to 155,000, or 181 per cent.; Liège, 46,000 to 160,000, or 248 per cent. In the matter of population, Antwerp passed Brussels during the years 1870 to 1880, and at the present moment the former city has about 5,000 inhabitants more than the latter. There is another curious point in connection with these statistics, and that is the increase in the foreign element. Since the year 1891, immigration has exceeded emigration to the extent of several thousands. Since 1846 the proportion of foreigners to the total population has increased from 2·18 to 2·82 per cent. In 1890 France was represented by 64,800 persons, Holland by 47,459, Germany 38,397, and England by 4,102 only.

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FRIDAY, NOVEMBER 5, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Forty-fourth Session will be held on Wednesday evening, the 17th of November, when an Address on "The Colonies: their Arts, Manufactures, and Commerce," will be delivered by MAJOR-GENERAL SIR OWEN TUDOR BURNE, G.C.I.E., K.C.S.I., Chairman of the Council.

Previous to Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made:—

NOVEMBER 17.—Opening Address by MAJOR-GENERAL SIR OWEN TUDOR BURNE, G.C.I.E., K.C.S.I., Chairman of the Council.

NOVEMBER 24.—"Progress of Metallurgy and Metal Mining in America during the last Half Century." By PROF. JAMES DOUGLAS.

DECEMBER 1.—"The American Bicycle—the Theory and Practice of its Making." By PROF. LEONARD WALDO, D.Sc.

DECEMBER 8.—"The Stockholm Exhibition of 1897." By BENNETT H. BROUGH. The RIGHT HON. SIR BERNHARD SAMUELSON, Bart., F.R.S., will preside.

DECEMBER 15.—"The Purification of Sewage by Bacteria." By SAMUEL RIDEAL, D.Sc. SIR DOUGLAS GALTON, K.C.B., F.R.S., will preside.

Papers for meetings after Christmas:—

"The Protection of Industrial Property." By J. F. ISELIN.

"The Projection of Luminous Objects in Space." By ERIC BRUCE.

"Aeronautics." By CAPTAIN B. BADEN-POWELL.

"Fruit Growing." By CECIL HOOPER.

"Stage Mechanism." By EDWIN O. SACHS.

"The Recent History of Papermaking." By CLAYTON BEADLE.

"The Preparation of Meat Extracts." By C. R. VALENTINE.

"Children's Sight." By R. BRUDENELL CARTER, F.R.C.S.

"Fireproof Construction." By THOMAS POTTER.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at 4.30 or 8 o'clock:—

January 20, February 17, March 10, 31, April 28, May 19.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday afternoons at 4.30 o'clock:—

January 18, February 15, March 15, April 5.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday evenings, at 8 o'clock:—

January 25, February 22, March 8, 29, April 26, May 17.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday evenings, at Eight o'clock:—

EUGENE F. A. OBACH, Ph.D., F.C.S., "Gutta Percha." Three Lectures.
November 29, December 6, 13.

CYRIL DAVENPORT, "Decorative Bookbinding." Three Lectures.
January 24, 31, February 7.

HUGH STANNUS, "The Principles of Design in Form." Four Lectures.
February 14, 21, 28, March 7.

PROF. W. NOEL HARTLEY, F.R.S., "The Thermo-Chemistry of the Bessemer Process." Three Lectures.
March 14, 21, 28.

DR. D. MORRIS, C.M.G., "India Rubber." Two Lectures.
April 18, 25.

PROF. CARUS WILSON, "Electric Traction." Four Lectures.
May 2, 9, 16, 23.

JUVENILE LECTURES.

Two Lectures, suitable for a Juvenile audience, will be delivered on Wednesday evenings, the 5th and 12th of January, at Seven p.m., by WILLIAM RAMSAY, Ph.D., F.R.S., on "Fire."

FOREIGN & COLONIAL SECTION.

A meeting of the Committee of this Section was held on Tuesday, 2nd inst. Present:—Sir Charles Malcolm Kennedy, K.C.M.G., C.B., in the chair; Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I.. Lieut.-Gen. Sir Andrew Clarke, G.C.M.G., C.B., Sir Douglas Galton, K.C.B., F.R.S., Sir Saul Samuel, K.C.M.G., C.B., with Sir Henry Trueman Wood, Secretary to the Society, and Mr. Edward Cunliffe-Owen, C.M.G., Secretary to the Section.

The programme of future arrangements was discussed.

Proceedings of the Society.

CANTOR LECTURES.

ALLOYS.

By Prof. Chandler Roberts-Austen, C.B., D.C.L., F.R.S.

Lecture IV.—Delivered April 5th, 1897.

The advances made in our knowledge of alloys since the last course of Cantor lectures was delivered in 1893 has been noteworthy. It will be well to deal first with that portion of the subject which has already been partly treated in the foregoing lectures of the present course. The question of points of solidification of alloys must still, therefore, occupy our attention.

Rudberg was, I believe, the first to give measurements of the points of solidification of a series of associations of two metals which would enable a curve to be constructed; his work, however, only dealt with the easily fusible series of lead and tin alloys, the melting points of which were well within the range of the ordinary mercurial thermometer.

I believe that a curve representing the points of solidification of the silver-copper series published 23 years ago by me in the "Proceedings of the Royal Society"* was the first which represented what is now justly called the "freezing point curve" of a series which is beyond the range of the glass thermometer, and therefore demanded pyrometric work. The method adopted was very imperfect, for it consisted in transferring a ball of iron from the just molten alloy to a calorimeter. The curve, however, plotted from the results of the experiments truly revealed the nature of the alloys under examination and, viewed in the light of modern knowledge, the curve shows to which group of solutions the copper-silver series belongs. At that time the melting point of silver was taken to be 1,040° C., while that of copper was unknown, but was believed to be much higher than subsequent experiments have proved it to be. Nevertheless, if the results given in that paper of over twenty years ago be corrected to bring them into accordance with modern measurements of the freezing points of silver and of copper, it will be seen that the concordance is somewhat remarkable. The more important part of my old curve of 1874, corrected for the freezing point of silver which is now accepted, is therefore plotted in Fig. 1, together with the results recently obtained by Heycock and Neville,* whose very accurate determinations may be taken to be final. In both sets of results per-centages by weight of the constituent metals are given, and not atomic per-centages. With reference to what is now called the *eutectic* alloy, that is the most fusible alloy of the series, the following statement was made by me in 1874 with reference to the alloys of silver and copper:—"I anticipated that Levol's homogeneous alloy, which contains 718·93 parts of silver in 1,000, would have the lowest melting point," but the experimental results pointed to another alloy containing 630·3 of silver per thousand, as having a still lower melting point. We now know that this result was due to the imperfections of the method which did not enable the last point at which the alloy remained fluid to be determined accurately, and this early inaccuracy was corrected in 1891, when almost the first experiments made with the recording pyrometer were devoted to a re-examination of the copper-silver series.† I showed that Levol's alloy appears to be the only one with a single freezing point, which points to its being the eutectic alloy of the series, but as there are theoretical reasons for considering that eutectics cannot be definite chemical compounds, and the composition of Levol's alloy corresponds accurately to the chemical formulæ, Ag_3Cu_2, I doubted whether it was really the eutectic alloy of the series, but any question as to whether Levol's alloy is the true eutectic of the silver-copper series has, since this lecture was delivered, been set at rest by

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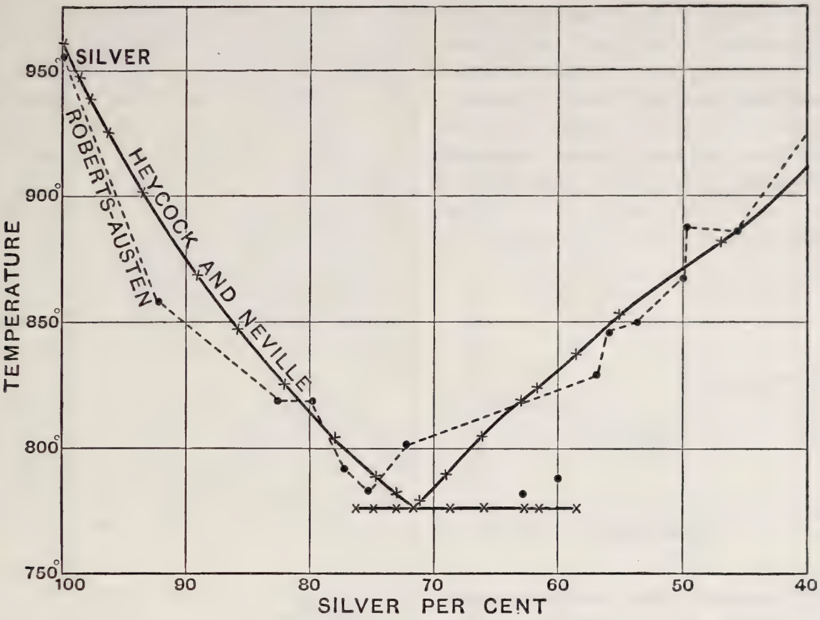
* "Proc Royal Soc.," vol. xxiii. (1874), p. 481.

* "Phil. Trans. Royal Soc.," vol. clxxxix. (1897), p. 25-70.

† First Report to the Alloys Research Committee. "Proc. Inst. Mech. Eng." Oct., 1891.

M. Osmond*, who, by microscopic evidence, proved the alloy to have the banded "pearly" structure of a eutectic alloy; that is it possesses exactly the structure which a solidified "mother liquor" should have. I am indebted to him for the accompanying photograph,† Fig. 2, of Levol's alloy which shows this beautiful pearly structure, and brings the eutectic of the silver-copper series into line with the "pearlite" or striated portion of Fig. 7 of the last lecture, which represents the eutectic of the carbon-iron series of solutions.

FIG. 1.—SILVER-COPPER ALLOYS.



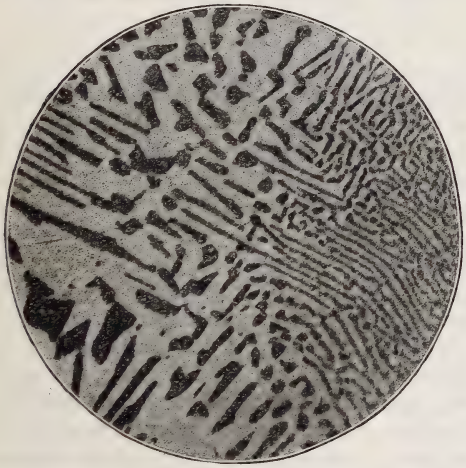


FIG. 2.

I have dwelt on these historical facts at some length because it was this old work, published by the Royal Society in 1874, which led my friend and colleague, Professor Guthrie, to examine the constitution of alloys in the course of a memorable research, which proved very fruitful in his skilful hands, as it enabled him to connect the *cryohydrates* of saline solutions with the *eutectics* in alloys. The whole question of the fusibility of alloys has been studied by Professor H. le Chatelier.* He points out that in considering alloys as solutions, it is necessary to modify the view in which ordinary solutions are regarded. In ordinary chemical language, it is usual to distinguish the solvent from the body which is dissolved, but really the two bodies play the same part. Many aqueous solutions, as he shows, can exist below the freezing point of water—that of chloride of calcium, for instance, which is liquid down to −55° C. He demonstrates that the typical curves which represent the fusibility of alloys have in each case corresponding curves of saline solutions, and he quotes experiments by Lœwel, Bakkhuis, Roozeboom, together with his own results, in confirmation of the facts. He specially refers to the curves of fusibility of isomorphous mixtures of certain organic substances first recorded by Kuster.[*] The result of le Chatelier's very interesting work is the division of the curves of alloys into the following classes:—

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* "Comptes Rendus," vol. cxxiv. (1897), p. 1094.

† M. Osmond has since published this photograph in his admirable communication to the *Association internationale pour l'essai des Matériaux*. Stockholm (1897).

* Professor le Chatelier's more important memoirs on this subject are the following:—

"Comptes Rendus," 1894, vol. cxviii., pp. 350, 415, 638, 709; 1895, vol. cxx., pp. 835, 1050.

"Bull. de la Soc. d'Enc.," May, 1895, p. 569.

"Recherches sur la Dissolution." "Annales des Mines," February, 1897.

In the first of these, *the metals dissolving each other give neither definite compounds nor isomorphous mixtures*. The curves of this class consist of two branches as is shown by the lead-tin curve in Fig. 3 [and Fig. 5 of Lecture I.], in which composition and temperature are co-ordinates, and it would appear that when a curve is composed of two branches only it is safe to conclude that after solidification the two isolated metals are simply in juxtaposition. In the second case, *the two metals give rise to one or more definite compounds*. Now as in the case of a solution of sulphate of soda in water one branch of the curve is peculiar and characteristic. If the compound which is formed between the two metals fuses without dissociation, there will be a maximum point in the curve which corresponds to the definite compound. In this case the curve will be of the form shown by the gold-aluminium curve, Fig. 4.

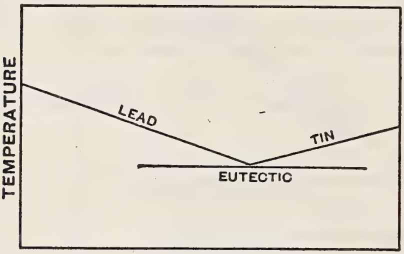

FIG. 3.

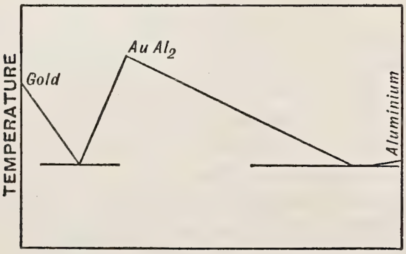

FIG. 4.

I had the good fortune to be the first to show[†] that such a curve could exist in the case of the metallic alloys with the point of minimum fusibility higher than that of the least fusible constituent, for the gold-aluminium curve was exhibited at a lecture delivered at the Royal Institution, on February 5th, 1892. M. LeVerrier has shown that a similar curve may be traced for the aluminium-copper series, and H. Le Chatelier[*] has found similar curves for the copper-tin. The copper-tin series has been very fully worked out by Stansfield in my laboratory.[†] In the case of my own curve of the aluminium-gold series the maximum point occurs, as Fig. 4 shows, at the alloy $Au\,Al_2$ the freezing point of which is no less than 35° higher than that of gold itself. If the compound formed in the alloy is dissociated, the portion of the curve which marks its presence will be rounded.

In the third case *the two metals which are dissolved in each other form isomorphous mixtures*. In this group the freezing points of the alloys of the series lie on a straight line, Fig. 5, and so far as I am aware the silver-gold alloys examined by Schertel[‡] presented the first known case. This question is very important, and I long ago suggested it as a subject for investigation to my colleague, Dr. Rose, who is now engaged upon it. M. Gautier has recently given several instances of such isomorphous alloys,[§] and among them the antimony-bismuth and the silver-zinc may be cited.

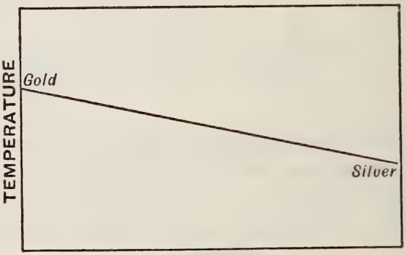

FIG. 5.

It will be remembered that all the curves to which reference has just been made, represent only the initial freezing points of the respective members of each series of alloys; there are in addition to these points the various *eutectic* alloys of each series, there being usually, as has already been stated, only one alloy in each series in which the initial and the final freezing points coincide, and are blended in a single point. The study of these *eutectic* alloys in the case of metals with melting points beyond the range of the ordinary mercurial thermometer was begun, so far as I know, in the experiments with which I was entrusted by the Institution of Mechanical Engineers,* and the subject has been very fully developed in the Fourth Report communicated to the Institution at the end of 1896. Messrs. Heycock and Neville also record the presence of eutectics in the very valuable series of "complete freezing-point curves" which have recently been published by the Royal Society.† The pyrometric method they adopted does not in all respects appear to be well adapted for the detection of the presence of small quantities of eutectic alloys, and their work needs some amplification in this respect; but they have given us by far the best series of initial freezing points we as yet possess.

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[*] "Zeitschrift für Phys. Chem.," vol. viii., p. 577.

[†] "Proc. Royal Inst." 1892.

[*] "Bull. de la Soc. d'Enc.," May, 1895.

[†] "Proc. Inst. Mech. Engineers." 1897.

[‡] "Poggendorf Annalen," 1897, p. 368.

[§] "Bul de la Soc. d'Enc.," vol i. (1896), p. 1293.

The liquation of impurities in metallic copper formed the subject of an interesting paper by Mr. E. Keller,‡ who shows that when plates or ingots of copper solidify, the impurities are driven to the "centre of solidification," that is to the portion of the mass which solidifies last. They follow the order of their atomic volumes, and he states that the order of segregation in the case of the impurities in copper, in the main, corresponds with that in lead bullion recorded by Schertel.§ Since the lecture was delivered an interesting paper showing the distribution of gold and silver in lead has been published by Mr. Arthur Claudet.||

Turning to quite another subject, M. J. B. Senderens¶ has made a very interesting series of experiments on the precipitation of one metal from solution by another metal. He points out that Richter in his researches, published between the years 1796-9, was led to the promulgation of a law which is now expressed as follows:—"Metals are precipitated from their saline solutions atom for atom of the same valency." Senderens shows that this is not rigorously accurate, as the amount of the precipitating metal is always in excess. For instance, take the well-known reaction employed in refineries for the precipitation by copper of silver from its solution as sulphate, in accordance with the equation:—

$$Ag_2So_4 + Cu = Ag_2 + CuSo_4.$$

If a solution of sulphate of silver containing 4·5 grammes of the salt in the litre of water be employed, it will be found that after a plate of copper has been immersed in the solution for seven days, that it will have lost 0·012 gramme more than theory demands. Senderens shows that this fact is of singular interest in relation to the allotropy of iron, but his work is quoted here on account of its bearing on the formation of alloys in the "wet way." He points out that several Chemists have thought that alloys might be so prepared, and that among them Planche and Brugnatelli* may be specially mentioned, and that Gay Lussac† at first favoured the opinion, but abandoned it later.‡

The history of this subject is very interesting. So long ago as 1857, Odling§ published a paper on "The Reciprocal Precipitation of the Metals," the outcome of a paper he had communicated to the Cheltenham meeting of the British Association in 1856. The paper is a very remarkable one, for Odling shows that in one experiment only 0·72 of an equivalent of cadmium precipitated an equivalent of copper from its solution of neutral chloride. He also pointed out that conversely, if clean copper foil be placed in chloride of cadmium, it will precipitate cadmium on the foil, and he found, moreover, as he says, "that a piece of copper coated with cadmium and a coil of copper and cadmium foils rolled up together behave very differently when treated with hydrochloric acid ..... the metallic deposit of cadmium partakes of the character of an alloy," and he attributes this precipitation of one metal on another "to the affinity of one metal for the other." In other words, he formed alloys in the wet way.

More recently Mylius and Fromm|| have shown that alloys may be precipitated from dilute solutions by zinc, cadmium, tin, lead, and copper. Thus a strip of zinc plunged in a solution of sulphate of silver, containing not more than 0·03 grammes of silver in the litre, becomes covered with a flocculent precipitate which is a true alloy of silver and zinc. In the same way when copper is precipated from its sulphate by zinc the alloy formed is brass. They have also formed certain alloys of definite composition such as $AuCd_3$, Cu_2Cd, and more interesting still, Cu_3Sn. I have elsewhere pointed to the interest these experiments

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* "Proc. Inst Mech. Eng."

† "Phil. Trans.," loc. cit., and "Trans. Chem. Soc." (1897), p. 383.

‡ "Trans. American Institute of Mining Engineers." Chicago Meeting, Feb., 1897.

§ Quoted by Hofman. "Metallurgy of Lead," p. 244.

|| "Trans. Institution of Mining and Metallurgy" (1897).

¶ Senderens. "Bull. Chem. Soc., Paris," vol. xv. (1896), p. 208, 691; and vol. xvii. (1897), p. 271.

* "Journ. de Phys. et de Chem.," vol. iii, p. 426.

† "Ann. de Chim.," vol. lxxviiii., p. 91.

‡ "Ann. Chim et Phys.," vol. vii., p. 219.

§ "Chem. Soc. Journ.," vol. ix, (1857), p. 289.

|| "Ber. d. d. Chem. Gess.," vol. 27, 1894, p. 630.

possess in relation to the diffusion of solid metals,* and I may add that many years ago I showed that the interpenetration of iron and copper will take place, during the electro-deposition of copper, even through an electro deposit of nickel on the copper.

Senderens points out that alloys will probably be produced in even more concentrated solutions than those employed by Mylius and Fromm, and he reminds us that Gay-Lussac showed that in the reduction of a solution of nitrate of silver by copper, the first portions of silver deposited are usually pure.

It is singular that when lead is reduced from its acetate by zinc the reduced lead appears to be pure, and it is well to remember that lead reduced from its sulphate by zinc (Bolley) has been claimed as an allotropic variety of the metal.

Among the more recent developments of our knowledge of alloys are the experiments by Heycock and Neville on the alloys of sodium and gold. They find that when sodium dissolves gold, if the resulting alloy is treated with alcohol and finally with water, a beautifully crystalline mass is left consisting of lustrous needles.† They are of a full brassy colour, but if they are heated to about 200° C. they become incandescent, and their colour changes to that of pure red-gold. After ignition, but not before, the residual sodium can be extracted with water and estimated. The per-centage of sodium agrees pretty well with the formula Au_3Na.

In a very interesting lecture delivered April 2nd, 1897, at the Royal Institution, Heycock showed that by the aid of the X rays the crystals of opaque gold might be seen in the sodium which is transparent to the X rays, and in this way liquation in the sodium-gold series may be studied during solidification.

One other question of much interest is being investigated by Heycock and Neville.‡ It is connected with the curious behaviour of the zinc-silver series of alloys. Percy,§ in examining this series, called attention to the fact that an alloy containing 49·72 per cent. of silver, and 50·28 zinc, has a surface which was "copper-red immediately after solidification." "The colour of its fracture when broken cold was white and very bright, but when broken hot the fracture immediately acquired a yellow, red, purple, or blue tarnish according to the temperature." Dr. Percy's collection, now at the Royal School of Mines, contains the specimens he prepared, and the fractured fragments vary from golden yellow to blue. The great interest of Heycock and Neville's work is derived from the fact of their showing that the colour is not as Percy thought due to tarnish, for they find that the colour may be produced by heating the alloy to 150° in *vacuo*, and cooling it quickly. If the alloy be placed on an iron plate, heated by a gas flame from below, and if it be then quenched in water, the red colour will appear. It seems to me that this is probably due to an allotropic change analogous to that already described in the case of the lead, bismuth-tin alloy* known as Newton's metal, more especially as the change of the normal modification to the red may certainly be produced by longitudinal stress under circumstances in which the alloy does not become heated. It is interesting to remember also in connection with the allotropy of this alloy that zinc has a critical point at 150°.

With reference to the coloured alloys, Gautier has recently pointed out† that certain members of the silver-cadmium series are violet; and suggest the well-known violet alloy of copper and antimony, but in its case one of the metals, the copper, is a coloured one. It is strange that the union of metals with such faint colouring as silver, zinc, and cadmium should produce a mass which is capable, under suitable thermal treatment, of becoming highly coloured.

It is really remarkable how much has of late years been done in elucidating the nature of alloys, but much remains to be done. Guthrie's great generalisation respecting the constitution of eutectic alloys has been most fruitful, and it seems certain that they at least are not chemical compounds. Eutectics always appear to solidify with a fine grained structure like the pearlite of the carbon-iron series, and in eutectic alloys we shall probably find that movements in the *solid* are most pronounced and interesting. With reference to the influence of valency in alloys, Neville has made the following very suggestive observation.‡ He says: "Dr. Foerster § suggests that alloys of definite composition, such as AuCd, Cu_3Sn, and others, many of which do not obey the ordinary laws of valency may be held together rather after the fashion of double salts; may, in fact, be *molecular* and not atomic compounds. In this case they may be dissociated when in solution, but, like the alums, exist in the solid form." He forcibly adds: "It is certainly somewhat difficult to imagine that the electropositive and self-saturating atoms of gold and cadmium can be held together in the molecule AuCd by forces similar to those which maintain the equilibrium of a molecule of hydrochloric acid."

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* Bakerian lecture, loc. cit. (1897).

† "Science Progress," vol. iv. (1895), p. 183.

‡ "Proc. Phil. Soc. Camb.," vol. ix., part IV.

§ "Metallurgy of Silver and Gold," 1880, p. 170.

* "Second Report to the Alloys Research Committee," p. 127.

† "loc. cit."

‡ "Science Progress," vol. iv., 1895, p. 187.

§ "Naturwissenschaftliche Rundschau," 1895.

The remarkable property which some alloys of nickel and iron possess of having a coefficient of expansion nearly equal to zero suggested the desirability of employing these alloys for the construction of measuring instruments. With this object in view M. Guillaume* has determined the densities and modulus of elasticity of a series of alloys of iron with 4 to 45 per cent. of nickel. One curious result in the case of alloys with 25 per cent. of nickel is that a rule made of this alloy and annealed at a given temperature continues to elongate when it is kept at a lower temperature. He also finds that an alloy containing 22 per cent. of nickel expands when it is heated considerably more than ordinary steel does, but an alloy of iron with 37 per cent. of nickel hardly expands at all, so that the presence of an additional 15 per cent. of nickel in nickel-iron alloys is sufficient to entirely change the nature of the metal.

The most recent work on the microscopic examination of alloys is that of M. Charpy, who has arrived at the following conclusions. The microscopic examination of metals renders it possible to obtain indications as to the nature of the work to which the sample has been subjected. It furnishes also important information as to the chemical constitution of alloys. It affords in some measure a rapid analysis of metallic alloys. It renders it possible to establish the fact that the solidification of alloys is effected in the same way as in the case, which is easier to observe directly, that of the solidification of saline solutions, and that binary alloys are usually formed of two constituents only, whatever may be the number of definite compounds formed by the two allied metals.

The type of the normal constitution presents, therefore, crystals of a simple metal or of a definite compound, surrounded by a second constituent, which is usually a eutectic mixture, which is itself formed of two finely divided elements, of which one is that which forms the crystals. The composition of the eutectic mixture remains constant, the proportion of the isolated crystals varies with the per-centage composition of the alloy.

Beyond this normal type, in which it is necessary to include the limited cases which correspond respectively to a pure definite compound, or to a pure eutectic mixture, there is only a second type, that of metals which give isomorphous mixtures. These alloys then are formed, whatever may be their composition of a single kind of crystal occupying the whole mass; usually, the composition and the properties vary continuously in each crystal. Although there are a small number of metals which can form isomorphous mixtures, it seems that there are many cases of definite compounds of two metals which are isomorphous with one or other of them. Microscopic examination leads, for instance, to the prediction of a compound of tin and antimony containing about 50 per cent. of tin and isomorphous with antimony.

There also appears to be a compound of antimony and silver containing about 20 per cent of antimony and isomorphous with silver; a compound of tin and silver containing 30 per cent. which is isomorphous with silver. These are, however, only indications which demand confirmation in the attempt to isolate these compounds.

The constituents of metallic alloys usually fall out in the form of *crystallites* and not as well-defined crystals. The form of these constituents is usually only approximately indicated. But apart from this character it is possible to recognise these constituents by their colour, their hardness, and especially by the way in which they behave in relation to various reagents.

The method of preparation, and especially the degree of rapidity of solidification, modifies considerably the dimensions of the *crystallites*, but it does not seem to exert any other influence on the constitution of the alloy.

Among the numerous experimenters who are now studying the constitution of alloys by micro-metallography, Mr. Stead is taking a very high place. He has sent me some admirable micro-photographs of the tin-antimony-copper alloys, and of many others.

Not the least singular of recent observations is one which will be found in a paper by M. Osmond and myself. Osmond finds that a cast mass of gold alloyed with $\frac{2}{10}$ per cent. of antimony shows, when etched with sulphuric acid, a large crystalline structure, but if it be annealed at a temperature of only 200°, the original structure disappears, and etching with sulphuric acid then reveals a fine-grained structure resembling hardened steel. This transformation of the structure of a metal at a temperature so far below its melting point, in the presence of only $\frac{2}{10}$ per cent. of a foreign body, appears to open up a new field for research.

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* Comptes Rendus," vol. cxxiv., 1897, p. 176, and *ibid.* p. 752, and p. 1,515, also vol. cxxv., 1897, p. 235.

I wish that space permitted me to deal with the curious problems involved in the constitution of such alloys as manganin, platinoid, and other alloys of this class; these must, however, be left for a future occasion. I will content myself with pointing out, in conclusion, that the tendency of modern research in connection with alloys is towards the study of molecular movement in solid masses, and to what is called the atomic grouping or "chemistry in space" of the allied atoms.

Miscellaneous.

*A GREAT SOUTH AMERICAN WATER SYSTEM.**

As is well known, the trade winds sweep along the equatorial belt across the Atlantic ocean from east to west at stated and well-defined periods of the year. On encountering the South American continent they are not detained in their course, as the land is low and extends westwards in vast expanses of plains not unlike the Russian steppes or the Pampas that form the territory of the Argentine and the other Republics that lie towards the extreme south of the continent.

The course of these trade winds is only stopped by the mighty Cordillera of the Andes, which runs along the whole of the South American continent, not far from the coast of the Pacific ocean. It is on the summit of these mountains that all the moisture gathered by the winds during their long flight is deposited. In some parts the height is such that, notwithstanding the fact that the locality lies in the very heart of the tropics, the moisture crystallises into snow and melts slowly. In other altitudes it condenses into water and flows downwards, forming a series of torrents and streams which precipitate themselves along the mountain flanks, seeking the lower levels.

Two great water systems are thus formed, one towards the south of the equator—that of the Amazon—and another some degrees to the north, and above the equator—that of the Orinoco; the first one the largest river in the world, and the other the third largest stream of water known, since it is only excelled in volume by the Amazon and by the Congo.

The Orinoco is to all intents and purposes an inland sea. Like the ocean it has calms and tempests, and at times its waves lash with fury the sands and the rocks along its banks. It was first discovered by Columbus, who sailed across its mouth, but did not venture inland. Towards the fourth decade of the sixteenth century Diego de Ordaz entered the river, and after navigating its course for about twelve hundred miles, deviated into one of its most important tributaries, the River Meta, which he ascended until he found himself not far from the first spurs of the Cordillera which dart into the plains. Here he abandoned his ships and betook himself to the land, climbing the abrupt sides of the mountains until he arrived at the vast plateau of Bogota, the seat of the empire of the Muiscas and the Chibchas, second only in its power and development amongst those found in the new world after the discovery by Columbus, to those of the Astecs and of the Incas in Mexico and Peru respectively. Here he encountered two other expeditions of Spaniards who had come, the one from the north, from the shores of the Atlantic, and the other from the south, having entered the continent by the Pacific coast, all in quest of gold, searching for that famous Eldorado which lured the conquerors of the new world from one region to another and from one zone to a more remote one.

The aspect of the Orinoco, with very slight alterations to be found at places far distant from one another, remains the same as when the daring Spanish adventurers navigated its waters for the first time. Its course runs first from south to north until it encounters a low range of mountains, or rather hills, which deviate the stream into an easterly direction. A struggle of centuries must have taken place at this spot where, along a stretch of about thirty miles, the river is encased within very narrow limits, and rushes madly between the granite walls on either side, and plunging into deep and wide hollows, where the waters froth and bubble, and seem to rest prior to darting again through other and similar straight passages, and so on until they reach the open plains, and follow their course uninterrupted to the sea.

These rapids divide the river into two well defined parts—the Upper and the Lower Orinoco—and have acted as a barrier, which has kept the lands and the rivers beyond it almost unknown to and unexploited by man. One detail is worthy of mention, namely, that the rapids of the Orinoco are not due, as is the case of other great rivers, to a sudden and great descent of level; they are the result of the compression of an immense volume of water into a very narrow channel, studded with mighty rocks, which have withstood the onslaught of the waters, a channel along which the waters rush with extreme violence and rapidity.

The numerous tributaries that form themselves into the lordly current known as the Orinoco, flow into it in all directions, from the north, from the south, from the east, and from the west. Most of them are navigable and receive other affluents, which in their turn are navigable also, so that the whole system constitutes a vast and prodigious network of rivers, carried deep into the very heart of the continent, to the foot of the mountains, and into the inmost recesses of the forests and plains. This network is, in truth, a complicated system of natural highways, which, were they placed longitudinally, would attain a length of many thousands and thousands of miles. Besides the running waters of the rivers, there are certain other water channels, called Caños, which connect some of the rivers with the others in a similar way to that obtained in other countries, by means of artificial canals. Amongst these, the Caño of the Casi Quiare deserves special mention, as it connects the system of the Orinoco with the Rio Negro, which, in its turn, froms part of the Amazon system, so that those two great inland seas, the Orinoco and the Amazon, are united by these means.

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* Contributed by Señor Don Santiago Pérez Triana, who has lately returned from a canoe voyage on the Orinoco.

Two well-defined seasons divide the year in the vast valley through which the Orinoco tends its course. The wet season, lasting from May to November, and the dry season from November to May. The trade winds blow during the dry season and clear the atmosphere from the miasmas and exhalations of the soil, purifying it and rendering the climate cool and salubrious. Evidently the influence of population would tend to make these regions far more healthy and inhabitable than what they are to-day.

The forests abound in all sorts of natural wealth; precious timbers, medicinal and resinous plants, india-rubber, and all the best known and most highly prized of the tropical products are found in exuberant abundance. The plains themselves are covered with natural grass, which affords the best kind of pasture, whereon the flocks thrive and multiply as rapidly as anywhere else on the surface of the globe; but little use is as yet made of all this immense supply of natural wealth. Along the Lower Orinoco there are some large cattle estates studded here and there, at immense distances from each other. On the shores of one of the largest tributaries, the Caura, and those of the Orinoco itself near the Caura, large forests of Tonga bean—a species of aromatic almond used for medicinal purposes and for the preparation of perfumes—have been discovered and exploited for quite a number of years. Some few attempts at exploiting the rubber forests have been made with fairly good results, but this may be said to constitute all the work thus far done towards exploiting these regions.

The only city deserving that name which is found on the Orinoco, is the old city of Angostura, now Ciudad Bolivar, named thus in memory of the liberator of the northern republics of South America. It was built by the Spaniards on a bluff overshadowing the river, 300 miles from its mouth, at a place where its waters are encompassed within a very narrow strait, as the word Angostura indicates "narrowness." From this city steamers ply up the stream about every fortnight as far as the river Apure, two or three hundred miles to the west, and then turn into that river and up to the old city of San Fernando; and this is the sum total of the present navigation existing on the Orinoco, with the exception of the ocean steamers that penetrate into the river from the sea, and sail as far as Ciudad Bolivar.

The lonely traveller paddling along slowly in his canoe, or sailing along with the wind, when it is favourable, contemplates the exuberant natural wealth displayed on both shores of the river as they pass before his eyes, admires the magnitude of the numerous affluents that flow into the main stream from either side, and unconsciously forms the conviction that all these vast natural elements must necessarily be destined to form, some day, the basis of a mighty centre of civilisation and human industry, towards which end nature has so lavishly contributed all her gifts, even to the facility of means of transportation, the high roads open to commerce, without which no people can attain greatness or large industrial and commercial development.

Beyond the rapids, that is to say on the Upper Orinoco, the forests are thicker, the affluents more numerous, and the climate healthier. Many tribes of Indians still remain scattered in those boundless regions. They are of a tame and peaceful disposition, and can be brought under the sway of civilisation without any great effort or difficulty.

One special source of wealth attracts the eye of the traveller in the Upper Orinoco and its affluents. That is the abundance of rubber forests of identical quality to those which are to be found on the Upper Amazon. At this present day, rubber forests are being sought for in all directions, and yet those of the Orinoco seem to be forgotten or ignored.

The Republics of Colombia and Venezuela are the owners of the immense regions watered by the Orinoco. Little is known in either of them about this important part of their territory, and certainly no efforts are being made to obtain from it the products which it so abundantly offers. The problem of exploiting these vast regions is not one of difficult solution. A few steamers on the lower river, a few more on the upper and its numerous tributaries, and some sort of railway along the banks to connect the two parts of the river, facilitating the passing of the rapids, is all that is required. It is a work to be undertaken with the protection of the two Governments, as from the moment that private individuals can be sure of the means of transportation, they would flock to those regions, where wealth can be obtained with more certainty and less danger than in the goldfields now and anon found in different parts of the world, to which thousands are attracted, and where so many hopes and so many lives are destroyed and lost.

It is to be hoped that this vast region will ere long attract the attention of those able to place it within the reach of modern industry and commerce.

Energies that lie latent in the old world, and ambitions that are unsatisfied, would find on the Orinoco and its shores, an ample and remunerative field.

JAPANESE MUSHROOMS.

Mr. Robert P. Porter, who has been conducting investigations into the industries of Japan, states that one of the most interesting studies in that country is the growing of mushrooms in the Shikoku Island, where most of the camphor is produced. This is an important article of export, mostly to China, and during the year 1895, the last year for which the returns are available, the quantity of mushrooms exported from Japan to all countries amounted to 1,780,597 lbs. Of the numerous species of edible mushrooms, the one called Shütake is the most important, being abundantly exported abroad and also used for many culinary purposes at home. Logs which are used for cultivating this mushroom are various species of oak. The principal districts where this mushroom is produced are the provinces forming Shikoku, Kiushiu, Wakayama, and Shiozuka prefectures. Oak trees 25 to 33 years old are felled in the autumn, and incisions made with axes at intervals of 3 or 4 inches, the incisions generally reaching the woody layer. The trees are then cut into logs of 4 to 5 feet in length and left in dark secluded parts of the forest. After the third year, mushrooms make their appearance in the incised portions. When the growth lessens they are replaced by new logs. The mushroom grows at each season of the year, winter, spring, summer, and autumn, but the growth in winter and spring is the result of artificial stimulus. The logs are steeped in water for a number of hours, according to the dryness of locality, and then struck with pommels or axes to prepare the beds for facilitating the growth of the mushrooms. The autumn crop is the most abundant. After being collected, mushrooms are dried either by the sun or by artificial heat.

SEWING NEEDLES IN GERMANY.

The sewing needle, though small, forms a very important article of commerce in Germany. While formerly England supplied that country with needles, this industry, according to the United States Consul at Annaberg, has during the last few years developed to such an extent that the Germans are able to meet their English competitors, not only on the markets of the world, but in the British colonies and in England as well. The principal seats of the industry are Aix la Chapelle, Burtscheid, Iserlohn, Altona, Nuremburg, and Schwalbach. The factories of Aix la Chapelle alone produce 50,000,000 needles weekly. The following figures show to what extent the exports from Germany of these needles have developed. During the eight years from 1880 to 1887 the German export of needles of all kinds (embroidery, knitting, darning, sewing, and sewing-machine needles) amounted to 11,600,000 lbs., of the value of £2,500,000. The following eight years make a still better showing. During this period the quantity exported was 15,000,000 lbs., valued at £3,000,000. The enormous growth in the production of this article is due principally in the export trade to China, where Germany seems to entirely control the market. Other countries importing German sewing needles are British East Indies, France, the United States, Austria, Hungary, Italy, and Turkey. In conclusion the American Consul says:—"Under the protection of their Government the Germans have built up a needle industry which commands the respect of the world. At first they imitated the English methods of manufacture, but their superior technical training soon enabled them to discover the defects of the English machinery, and they adopted new and improved devices, and followed their own course of manufacture. The infant industry of a few years ago has become one of national importance. The manufacturers go into the markets of the world, preferably into new countries, and compete successfully everywhere."

CHINESE OIL TREE.

According to a recent report of the United States Consul-General at Shanghai, the Chinese oil tree (*Aleurites cordata*) belongs to a family very common in China and known as the "tung." Oil is also said to be derived from other varieties of the tung, but it is the "ying tzu tung" which is especially cultivated for this purpose. It is found chiefly in Hunan Hupeh and Szechuen. Hosie in his "Three Years in Western China" says "that it grows in great abundance on the banks of the Yangtze, west of Ichang, that it seems to prefer thin solid rocky ground, and grows to the height of fifteen feet. It has large, beautiful green leaves, small pink white flowers, and large green fruit like an apple." The seeds are large and poisonous, and it is from them that the oil is expressed. The fruit is gathered in August and September. The machinery used for extracting the oil is very rude, consisting of wooden presses with wedges. It is sent to market in tubs with tight-fitting lids. The principal place of export is Hankow, whence in 1895 there were 290,631 piculs (38,741,000 lbs.), shipped chiefly to the Chinese ports, the value of which amounted to about £232,000. Small quantities were exported from Kinkiang and Canton also. During the same year there was imported at Shanghai a quantity estimated at 90,385 piculs (12,048,320 lbs.), valued at about £78,000, of which more than 35,000 piculs (4,665,000 lbs.) were re-exported. The oil is used in the manufacture of paint and varnish, waterproof paper and umbrellas, and in Western China, it appears, for lighting also. The greater part, however, is consumed in calking, for which purpose it is everywhere used in China. In applying it to the bottom of the boats it is put on hot, but for parts not commonly submerged it is put on cold and in thin coats. The upper part of a Chinese boat is oiled once or twice a month. This gives it a clear glossy appearance and preserves the wood. It is said to be somewhat adulterated in the retail shops, and cotton-seed oil, it is reported, is used for the purpose.

Notes on Books.

THE PRINCIPLES OF CHEMISTRY. By D. Mendeleef. Translated from the Russian by G. Kamensky; edited by T. A. Lawson. London: Longmans. 1897.

The first edition of this work was published in Russia about the year 1870. In 1889, the fifth Russian edition appeared, and this was translated into English by Mr. Kamensky, with the assistance of Mr. Greenaway, in 1891, and also into German and French. The English translation appeared in 1891.

Another English edition has now been published. This is translated by Mr. Kamensky from the sixth Russian edition, and is edited by Dr. T. A. Lawson.

The reputation of the author may be accepted as a sufficient guarantee of the value of the work, while the fact of a second edition having been called for within six years of the appearance of the former version may be taken to indicate the appreciation of the book in this country.

The book is not a text-book, but a philosophical treatise—an exposition of the general principles of the science. For this reason it is not easy to indicate within brief limits the method of treatment or the subject-matter. Perhaps this may best be done by a brief summary of the contents. This may at all events show how different is Professor Mendeleef's method from that of the ordinary text-book.

The first few chapters have for their subject—water, its compounds and composition; hydrogen, oxygen, nitrogen, and their compounds; air. Then comes a chapter on molecules and atoms, the laws of Gay-Lussac and of Avogadro. Next come carbon and the hydrocarbons; compounds of carbon with oxygen and nitrogen. Then sodium chloride and the halogens. Then potassium and some of the rarer metals, and spectrum analysis. The last chapter of the first volume is devoted to the valency and specific heat of the metals.

The second volume commences with a chapter on the grouping of the elements and the periodic law, and in the succeeding chapters the author treats of the various elements in order, arranged under the groups into which he was the first to classify them.

In appendixes are given Professor Mendeleef's Faraday lecture, and his lecture before the Royal Institution, with a memoir of his (dated February, 1895) on "Argon."

HINTS ON THE CHOICE OF GEOGRAPHICAL BOOKS. By Hugh Robert Mill. London: Longmans, Green and Co. 1897.

The principal object of this book is to supply teachers of geography with a list of the best available books on geography published at a reasonable price. It is in fact a bibliography of low-priced geographical books.

The lists of books are arranged in classified sections, with a short introduction to each section, and a general preface. The sections are:—Methods of teaching geography; Representative text-books; Atlases and Maps; and books of general geographical reference; then come lists of books on the differeut sections into which geography is divided—Mathematical, Physical, Bio-geography, and Anthropogeography; then books on different parts of the world—the British Empire, Europe, Asia, Africa, America, Australasia, the Polar regions; with a final list on general travel and biography. The lists only profess to contain English books, but in some cases gaps in English geographical literature are filled by adding the titles of French or German standard books. In addition to the title of the book, in each case a short critical note is generally added indicative of the nature and value of the book. Prices are given in most cases, the prices being those at which the books were published.

For teachers, librarians, and general students of the subject, a work prepared with so much care, as has evidently been spent upon this, cannot fail to be of considerable use.

FIRST PRINCIPLES OF ELECTRICITY AND MAGNETISM. By C. H. W. Biggs. London: Biggs and Co.

This book, by the editor of the *Electrical Engineer*, is based on a series of articles which appeared in that paper, and were founded on the examination syllabus of the City and Guilds Institute. It is intended for beginners in practical work, and the needs of the begineer seem to be kept clearly in view throughout. A simple account is given of the general principles involved and of their application in the machines and apparatus now generally in practical use. Questions are added at the end of each chapter which will enable the student to test his appreciation of the information given, and the book is completed by a very full and elaborate index.

CATALOGUE OF THE PASSMORE EDWARDS LIBRARY. London: Bradbury, Agnew, and Co. 1897.

The St. Bride Foundation Institute for the Technical Education of Printers became possessed of the fine collection of works on printing made by the late William Blades. Rich in old typographical books, this collection did not include modern technical works, and, with the laudable intention of forming a complete library of books relating to printing and the allied arts, the governing body of the institute applied to Mr. Passmore Edwards for assistance. A liberal donation of £500 was the response, with the result that the institute was enabled to form what from its catalogue appears to be a very complete library of the subject. This catalogue, prepared by Mr. John Southward and the librarian, Mr. F. W. T. Lange, is therefore practically a bibliography of modern books on printing, and has a value of its own apart from its usefulness as a catalogue. It does not include the books in the Blades Library, which perhaps may be a matter for regret.

A Practical Treatise upon Warming Buildings by Hot Water and upon Heat and Heating Appliances in General. By Charles Hood, F.R.S. Re-written by Frederick Dyer. Third new edition fully revised to date. London: E. and F. N. Spon. 1897. 8vo.

The late Mr. Hood's standard work was first published in 1837, and its author was the pioneer in the art of warming buildings by hot water. The editor remarks that "it is remarkable that the rules and tables he [Mr. Hood] then laid down should still be universally followed, except that allowance has had to be made to balance his accurate experimental data with the less effective results we get in common practice." The book went through several editions during the author's lifetime, but in 1892 it was found necessary to rewrite it, and in the present edition Mr. Dyer has made a complete revision, descriptions of some new systems for buildings being given. The book is too well known as an authority on the subject to which it relates for it to be necessary to give any analysis of its contents. Mr. Dyer strongly recommends hot water engineers to construct for themselves a model apparatus of glass tubes, which will enable them to obtain an intimate knowledge of what happens in the apparatus such as no other means will afford them.

Obituary.

Sir Rutherford Alcock, K.C.B., D.C.L.—Sir Rutherford Alcock, who died on the 2nd instant, was a member of the Society for some years, and a Vice-President from 1880 to 1883. He frequently presided at the meetings, and was also a member of the Committee of the Indian Section, before which Section he read, on January 13th, 1882, a paper on the Opium Trade. Sir Rutherford Alcock, the son of Dr. Thomas Alcock, was born in 1809, and educated for the medical profession. He began his career on the medical staff of the British auxiliary forces in Spain in support of Isabella II. against the Carlists, and in Portugal in support of Maria II. against the Miguelists. He rose to be Deputy Inspector-General of Hospitals, and when he retired in 1837 he received many honours and decorations. In 1838 he published "Notes on the Medical History and Statistics of the British Legion in Spain." He was Consul at Foo-choo in 1844, at Shanghai in 1846, and at Canton in 1858. He was then transferred to the diplomatic service, and became Envoy Extraordinary, Minister Plenipotentiary, and Consul-General in Japan. In 1865 he was transferred to Pekin as Chief Superintendent of Trade in China, and remained there till 1870. When he was instructed to invite Japan to take part in the International Exhibition of 1862, he was unable to induce the Government or individual Japanese to give any assistance. He therefore undertook the task himself, with the result that Japan was well represented. Sir Rutherford was elected President of the Royal Geographical Society in 1876, and he was the author of several books besides the one already mentioned, as "Elements of Japanese Grammar," 1861; "The Capital of the Tycoon," 1863; "Familiar Dialogues in Japanese," 1863; and "Art and Industries in Japan," 1878.

General Notes.

Imperial Institute.—A lecture on Kafiristan will be delivered at the Institute by Sir George Scott Robertson, K.C.S.I., on November 19th. Members of the Society of Arts will be admitted to the lecture, and will have the privilege of introducing a friend.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 8...Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. Address on "Some Advances in Technical Chemistry during the Victorian Era," by Dr. Stevenson Macadam.

Surveyors, Savoy-street, W.C., 8 p.m. Opening Address by the President, Mr. Christopher Oakley.

Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Address by the President. 2. Mr. F. J. Jackson, "The Jackson-Harmsworth Arctic Expedition."

Camera Club, Charing-cross-road, W.C., 8¼ p.m. Rev. J. Perkins, "Photographic Record Work from an Archæological Standpoint."

Sanitary Inst., Margaret-street, W., 8 p.m. Prof. T. Roger Smith, "Sanitary Building Construction."

Tuesday, Nov. 9...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Papers on "The Manchester Ship Canal," by Sir E. Leader Williams, Messrs. Whately Eliot and E. Meade-King.

Photographic, 5A, Pall-mall East, 8 p.m. Mr. E. W. Maunder, "The Spectroscope."

Thursday, Nov. 11...Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. L. Epstein, "Accumulator Traction on Rails and Ordinary Roads."

Friday, Nov. 12...Physical, Chemical Society's Rooms, Burlington-house, W., 5 p.m. 1. Mr. J. Rose-Innes, "The Isothermals of Ether." 2. Messrs. F. S. Spiers and F. Twyman, "The Variation with Temperature of the Electromotive Force of the H-form of Clark Cells."

Correction.—Page 1164, col. 1. Line 6 has been misplaced. The first line should commence with *certain*, and the sixth line with *Stodart.*

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FRIDAY, NOVEMBER 12, 1897.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Forty-fourth Session will be held on Wednesday evening, the 17th of November, when an Address on "The Colonies: their Arts, Manufactures, and Commerce," will be delivered by MAJOR-GENERAL SIR OWEN TUDOR BURNE, G.C.I.E., K.C.S.I., Chairman of the Council.

Previous to Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made:—

NOVEMBER 17.—Opening Address by MAJOR-GENERAL SIR OWEN TUDOR BURNE, G.C.I.E., K.C.S.I., Chairman of the Council.

NOVEMBER 24.—"Progress of Metallurgy and Metal Mining in America during the last Half Century." By PROF. JAMES DOUGLAS.

DECEMBER 1.—"The American Bicycle—the Theory and Practice of its Making." By PROF. LEONARD WALDO, D.Sc. SIR OWEN TUDOR BURNE, G.C.I.E., will preside.

DECEMBER 8.—"The Stockholm Exhibition of 1897." By BENNETT H. BROUGH. The RIGHT HON. SIR BERNHARD SAMUELSON, Bart., F.R.S., will preside.

DECEMBER 15.—"The Purification of Sewage by Bacteria." By SAMUEL RIDEAL, D.Sc. SIR DOUGLAS GALTON, K.C.B., F.R.S., will preside.

Papers for meetings after Christmas:—

"The Protection of Industrial Property." By J. F. ISELIN.

"The Projection of Luminous Objects in Space." By ERIC BRUCE.

"Aeronautics." By CAPTAIN B. BADEN-POWELL.

"Stage Mechanism." By EDWIN O. SACHS.

"The Recent History of Papermaking." By CLAYTON BEADLE.

"The Preparation of Meat Extracts." By C. R. VALENTINE.

"Children's Sight." By R. BRUDENELL CARTER, F.R.C.S.

"Fireproof Construction." By THOMAS POTTER.

"Compensation to Workmen." By A. D. PROVAND, M.P.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursdays, at 4.30 or 8 o'clock:—

January 20, February 17, March 10, 31, April 28, May 19.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesday afternoons at 4.30 o'clock:—

January 18, February 15, March 15, April 5.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday evenings, at 8 o'clock:—

January 25, February 22, March 8, 29, April 26, May 17.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday evenings, at Eight o'clock:—

Dr. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E., "Gutta Percha." Three Lectures.

LECTURE I.—NOVEMBER 29.

The Raw Material.—The year 1847—Early history and the Society of Arts—General properties and distinction from Caoutchouc—Botanical derivation and geographical distribution—Expeditions in search of gutta trees and experimental cultivation—Analysis of particular specimens and of various commercial brands—Exports from Singapore, imports into the United Kingdom and fluctuation of prices.

LECTURE II.—DECEMBER 6.

The Cleaning Processes.—Mechanical cleaning process—Loss during mechanical cleaning—Chemical washing process—Chemical hardening process—Extraction from raw material and from leaves by means of solvents—Advantages and disadvantages of the different processes—Natural substitutes for gutta percha.

LECTURE III.—DECEMBER 13.

The Clean Material.—Chemical composition, mechanical and electrical properties—Application for various technical purposes—Use of hardened gutta percha for golf balls—Absorption of oxygen and behaviour towards ozone—Deterioration and preservation—Artificial substitutes for gutta percha—Concluding remarks.

CYRIL DAVENPORT, "Decorative Bookbinding." Three Lectures.
January 24, 31, February 7.

HUGH STANNUS, "The Principles of Design in Form." Four Lectures.
February 14, 21, 28, March 7.

PROF. W. NOEL HARTLEY, F.R.S., "The Thermo-Chemistry of the Bessemer Process." Three Lectures.
March 14, 21, 28.

DR. D. MORRIS, C.M.G., "India Rubber." Two Lectures.
April 18, 25.

PROF. CARUS WILSON, "Electric Traction." Four Lectures.
May 2, 9, 16, 23.

JUVENILE LECTURES.

Two Lectures, suitable for a Juvenile audience, will be delivered on Wednesday evenings, the 5th and 12th of January, at Seven p.m., by WILLIAM RAMSAY, Ph.D., F.R.S., on "Fire."

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Wednesday afternoon, 10th inst. Present: Sir Steuart Colvin Bayley, K.C.S.I., C.I.E. (Chairman), L. R. Ashburner, C.S.I., J. A. Baines, C.S.I., Sir M. M. Bhownaggree, K.C.I.E., M.P., Sir George Birdwood, K.C.I.E., C.S.I., H. M. Birdwood, C.S.I., Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., Sir Juland Danvers, K.C.S.I., Sir Charles A. Elliott, K.C.S.I., Sir James Lyall, G.C.I.E., K.C.S.I., A. Rogers, Thomas H. Thornton, C.S.I., D.C.L., W. Martin Wood, with Sir Henry Trueman Wood, Secretary to the Society, and S. Digby, Secretary to the Section.

The arrangements for the Session were considered.

Miscellaneous.

PARAGUAYAN TOBACCO.

Since the year 1893 the price of tobacco has fallen steadily in Paraguay, and in 1895 it was so low that it was found hardly worth the expense and trouble of cultivation. The crop raised in 1896, therefore, amounted to little more than was required for home consumption. Prices, however, according to a recent report of Consul Holmes of Asuncion, have gone up lately, and at the present time range from 2 dols. 80 cents (1s. 9d.) per arroba (25 lbs.) for *pito*, which is the lowest leaf, to 8 dols. (5s.) for *para*, the topmost and best leaf. The leaves are divided into seven classes, viz., *pilto*, *medio*, *regular*, *buena*, *doble*, *pinton*, and *para*. Efforts are being made to find fresh markets in Europe, but they are hardly likely to be successful so long as the present primitive methods of drying and preparing the leaf continue to be practised. The Paraguayan consuls in Bremen and Hamburg report that consignments of tobacco from Paraguay are frequently rejected because the leaves are found to be badly prepared, wrongly classified, and often mingled with sand. That Paraguay is a country well adapted, both as regards climate and soil, for the cultivation of the tobacco plant, there seems to be little doubt. Several Cubans, who paid a visit to Paraguay at the invitation of the Government, in order to study this question, go so far as to say that the soil in some parts is almost identical with that of Cuba, which produces ths best growths. About a year ago the Government placed two of these Cubans in charge of a plantation near Villa Rica, paying them salaries, and giving them a half share in the profits, besides providing labourers on the understanding that Cuban methods of cultivation should be employed, and the same taught to such Paraguayans as were willing to learn. The crop raised on this plantation, in 1896, though small, is said to be almost equal to the Vuelta Abajo tobacco of Cuba. In the year 1895, the amount of tobacco exported from Paraguay was 2,151,900 kilogrammes (4,734,000 lbs.).

INLAND NAVIGATION IN GERMANY.

No one who studies the underlying causes of German industrial progress can fail to notice the important and rapidly increasing rôle that is played by the canal and navigable rivers which are being improved and extended year by year, and which carry freights at such low rates that, according to the United States Consul-General at Frankfort, protective economists begin to complain that they render the importation of foreign merchandise altogether too cheap and easy. A few figures will show the enormous development of inland water transportation in Germany during the past ten or twenty years. Prior to the canalisation of the River Main from Frankfort to its confluence with the Rhine at Mayence, which was finished in 1886, only small boats ascended the river to this point; and Frankfort had a total river traffic of not more than 150,000 tons, against 930,000 tons of freight received and sent annually by rail, the per-centage of each being as 14 to 86 respectively. During the first five years after the river was canalised the water traffic rose to 700,000 tons against 1,400,000 tons by rail—an increase of 467 per cent. by river to 50 per cent. increase by rail. Since then the river traffic has steadily increased year by year to a total of 1,753,799 tons in 1896, to which is to be added 225,253 tons of logs and lumber arriving in the form of rafts from the Upper Main. Similarly the trade of Cologne rose from 200,000 tons in 1876 to 1,000,000 tons in 1896, and the grand aggregate of the German Rhine ports grew from 5,100,000 tons to 16,250,000 tons during the same period. The total length of German canals and inland waterways is 8,700 miles, and important extensions—such as the Oder Canal group and the Elbe Trave Canal—are still in course of construction. The Danube-Oder and Oder-Moldau-Elbe canals will, when completed, form a continuous waterway nearly 2,000 miles long, and will connect the waters of the Baltic with those of the Black Sea.

Obituary.

JOHN JACOB HOLTZAPFFEL.—By the death of Mr. Holtzapffel on the 14th October the Society has lost a member whose family connections with the institution date back to the early part of the present century. His grandfather, his father, and his mother were members of the Society, and his father also filled the office of Chairman of the Committee of Mechanics. Mr. Holtzapffel read a valuable paper on "Sand Blast Processes" at the evening meeting on April 3, 1895, for which he was awarded the Society's silver medal. In 1794, Mr. Holtzapffel's grandfather, a German by birth, came over to England and started a business of lathe-making and turning in all its branches, the first of its kind in those days. The factory was set up in Long Acre, where it remained till it was removed last September to the neighbourhood of Primrose-hill. The second head of the firm was Charles Holtzapffel, a son of the founder, and the author of the standard work on "Turning and Mechanical Manipulation." He only lived to publish the first two volumes, but these were said to have marked an "epoch in the literature of mechanics." His widow edited the third volume, which was published in 1850, three years after the death of its author. The fourth and fifth volumes were the work of Mr. J. J. Holtzapffel, who published them in 1879 and 1884 respectively. Mr. Holtzapffel was an Associate Member of the Institution of Civil Engineers, and also an active member of the Turners' Company, of which he was Master in 1879. He was in his sixty-second year at the time of his death.

General Notes.

IMPERIAL INSTITUTE.—The lecture on "Kafiristan," by Sir George Scott Robertson, K.C.S.I., will be delivered on Monday, the 29th inst., and not on Friday, the 19th inst., as announced by mistake in the last number of the *Journal.*

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 15...Sanitary Inst., 74A, Margaret-street, W., 8 p.m. Dr. G. Reid, "Sanitary Appliances."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. A. S. Flower, "Notes on Renaissance Architecture in Malta."

Camera Club, Charing-cross-road, W.C., 8¼ p.m Mr. Law Bros, "Primitive Ireland."

TUESDAY, Nov. 16...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on following papers:—"The Manchester Ship Canal," Sir E. Leader Williams. "The Eastham Division," Mr. Whately Eliot. "The Runcorn Division," Sir E. Leader Williams. "The Irlam Division," Mr. W. O. E. Meade-King.

Statistical, in the Theatre of the United Service Institution, Whitehall, S.W., 5½ p.m. Major P. G. Craigie, "Notes on the Subjects Discussed at the Meeting of the International Statistical Institute at St. Petersburg, 1897."

Photographic, 12, Hanover-square, W., 8 p.m. Mr. E. Sanger Shepherd, "A Review of Triple Printing Methods."

Zoological, 3, Hanover-spuare, W., 8½ p m. 1. Mr. E. T. Browne, "British Medusæ." 2. Dr. A. G. Butler, "Three Consignments of Butterflies collected in Natal in 1896 and 1897 by Mr. Guy A. K. Marshall. 3. Mr. Edgar R. Waite, "The Sydney Bush-Rat."

WEDNESDAY, Nov. 17...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Opening Meeting of the 144th Session. Inaugural Address by Major-General Sir Owen Tudor Burne, "The Colonies—their Arts, Manufactures, and Commerce."

Meteorological, 25, Great George-street, S.W. 7½ p.m. Mr. Richard H. Curtis, "Results of a Comparison between the Sunshine Records obtained simultaneously from a Campbell-Stokes Burning Recorder and from a Jordan Photographic Recorder."

Geological, Burlington-house, W., 8 p.m.

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Discussion on "The Pollution of Water Supplies by Encampments of Hop-Pickers, Casual Workers, Tramps, &c.," to be opened by Prof. W. H. Corfield and Miss M. A Chreiman.

Microscopical, 20, Hanover-spuare, W., 8 p.m.

THURSDAY, Nov. 18...Linnean, Burlington-house, W., 8 p.m. 1. Prof. A. Dendy, "Pontobolbos Manaarensis." 2. Mr. F. Chapman, "Haddonia, a new genus of Foramnifera."

Chemical, Burlington-house, W., 8 p.m. 1. Prof. A. W. Crossley and Mr. W. H. Perkin, jun., "The Decomposition of Camphoric Acid by Fusion with Potash or Soda." 2. Messrs. W. H. Bentley and W. H. Perkin, jun., F.R.S., "Experiments on the Synthesis of Camphoric Acid." 3. Dr. Frank Clowes and Mr. R. M. Caven, "The Action of Magnesium on Cupric Sulphate Solution." 4. Mr. H. J. Horstman Fenton, "Properties and Relationships of Dihydroxy Tartaric Acid."

Sanitary Inst., 74A, Margaret-street, W., 8 p.m. Mr. W. C. Tyndale, "House Drainage."

FRIDAY, Nov. 19...Imperial Inst., South Kensington, S.W., 9 p.m. Mr. F. G. Jackson, "Three Years in the Arctic."

CONTRIBUTIONS TO THE READING-ROOM.

The Council beg leave to acknowledge, with thanks to the Proprietors, the receipt of the following Transactions of Societies and Periodicals.

TRANSACTIONS, &C.

American Chemical Society, Journal.
American Institute of Electrical Engineers, Transactions.
American Philosophical Society, Proceedings and Transactions.
American Society of Civil Engineers, Transactions and Proceedings.
Architectural Association, Notes.
Association of Engineering Societies, Journal.
Australasian Association for the Advancement of Science, Report.
Bath and West and Southern Counties Society, Journal.
British Association for the Advancement of Science, Report.
British Guiana, Royal Agricultural and Commercial Society, Journal.
British Horological Institute, Horological Journal.
Camera Club, Journal.
Canada, Royal Society, Proceedings and Transactions.
Canadian Institute, Transactions.
Canadian Society of Civil Engineers, Transactions.
Chemical Society, Journal.
Cleveland Institution of Engineers, Proceedings.
Cymmrodorion, Honourable Society of, Transactions.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institute, Journal.
Geneva, Société des Arts, Bulletin de la Classe d'Industrie et de Commerce.
Geological Society, Quarterly Journal.
Imperial Institute, Journal.
Incorporated Gas Institute, Transactions.
India, Geological Survey of, Memoirs, Records and Palæontologia Indica.
——, Government of, Agricultural Ledger.
Indian Meteorological Department, Report.
Institute of Bankers, Journal.
Institution of Civil Engineers, Minutes of Proceedings.
Institution of Electrical Engineers, Journal.
Institution of Engineers and Shipbuilders in Scotland, Transactions.
Institution of Junior Engineers, Record of Transactions.
Institution of Mechanical Engineers, Proceedings.
Institution of Mining and Metallurgy, Transactions.
Institution of Naval Architects, Transactions.
Iron and Steel Institute, Journal.
Jamaica, Institute of, Journal.
Japan, College of Science, Imperial University, Journal.
Japan Society, Transactions and Proceedings.
Kew Gardens Bulletin.
Linnæan Society, Journal.
London Association of Foremen Engineers and Draughtsmen, Publications.
London Chamber of Commerce, Journal.
Lyon, Société d'Agriculture, Sciences et Industrie, Annales.
Manchester Literary and Philosophical Society, Memoirs and Proceedings.
Massachusetts Institute of Technology. Technology Quarterly and Proceedings of the Society of Arts.
Munich, Polytechnischer - Verein, Bayerisches Industrie-und-Gewerbeblatt.
National Association for the Promotion of Technical and Secondary Education. Record.
National Indian Association, "The Indian Magazine and Review."
Nederlandsche Maatschappij ter Bevordering van Nijverheid, Wekelijkoche Courant de Nijverheid.
New South Wales, Royal Society, Journal and Proceedings.
North-East Coast Institution of Engineers and Shipbuilders, Transactions.
Paris, Conservatoire National des Arts et Metiers, Annales.
——, Société d'Encouragement pour l'Industrie Nationale, Bulletin.
——, Société de Geographie Commerciale, Bulletin.
——, Société Internationale des Electriciens, Bulletin.
——, Société Nationale d'Acclimatation de France, Revue.
Patent Agents, Chartered Institute of, Transactions.
Patent-office, Illustrated Official Journal.
Pennsylvania (Western), Engineers' Society of, Proceedings.
Pharmaceutical Society, "The Pharmaceutical Journal."
Philadelphia, Academy of Natural Sciences, Proceedings.
——, Engineers' Club Proceedings.
Quekett Microscopical Club, Journal.

Royal Agricultural Society, Journal.
Royal Colonial Institute, Proceedings.
Royal Cornwall Polytechnic Society, Annual Report.
Royal Geographical Society, "The Geographical Journal."
Royal Institute of British Architects, Journal.
Royal Institution of Great Britain, Proceedings.
Royal Irish Academy, Transactions and Proceedings.
Royal Meteorological Society, Quarterly Journal.
Royal National Life Boat Institution, "The Life Boat."
Royal Photographic Society of Great Britain, "The Photographic Journal."
Royal Scottish Society of Arts, Transactions.
Royal Society, Philosophical Transactions and Proceedings.
Royal Society of Edinburgh, Transactions and Proceedings.
Royal Statistical Society, Journal.
Royal United Service Institution, Journal.
Sanitary Institute, Journal.
Society of Antiquaries, Archæologia and Proceedings.
Society of Biblical Archæology, Proceedings.
Society of Chemical Industry, Journal.
Society of Dyers and Colourists, Journal.
Society of Engineers, Transactions.
Society of Public Analysts, "The Analyst."
South Wales Institute of Engineers, Proceedings.
Victoria Institute, Journal of the Transactions.

PERIODICALS.

Twice a Week.

Chemiker-Zeitung.

Weekly.

Amateur Photographer.
American Architect and Building News.
American Gas Light Journal.
American Manufacturer and Iron World.
Architect.
Architecture and Building (New York).
Athenæum.
Bradstreet's.
British Architect.
British Journal of Photography.
Builder.
Building News.
Capitalist.
Chemical News.
Chemist and Druggist.
Chronique Industrielle.
Colliery Guardian.
Colonies and India.
Commerce.
Cosmos: Revue des Sciences.
Eclairage Electrique.
Education: Secondary and Technical.
Electrical Engineer.
Electrical Review.
Electrician.
Electricien.
Electricity.
Engineer.
Engineering.
Engineering Record (New York).
English Mechanic.
Gardeners' Chronicle.
Gardening World.
Herapath's Railway Journal.
Indian and Eastern Engineer.
Industries and Iron.
Invention.
Iron and Coal Trades Review.
Journal of Gas Lighting.
Journal d'Hygiène.
Land and Water.
Medical Press and Circular.
Miller.
Millers' Gazette.
Mining Journal.
Moniteur Industriel.
Musical Standard.
Nature.
Photographic News.
Photography.
Practical Engineer.
Produce Markets' Review.
Publishers' Circular.
Queen.
Revue Industrielle.
Sanitary Record.
School Board Chronicle.
Schoolmaster.
Scientific American.
Statist.
Surveyor.
Textile Mercury.
Warehouseman and Draper.

Fortnightly.

Brewers' Guardian.
Corps Gras Industriels.
Finance Chronicle.
Irish Builder.
Jeweller and Metalworker.
Moniteur des Produits Chimiques.
Perak Government Gazette.

Monthly.

Arms and Explosives.
Bookseller.
Brewers' Journal.
Building Societies' Gazette.
Cabinet Maker and Art Furnisher.
Canadian Patent Office Record.
Caterer and Refreshment Contractors' Gazette
Dyer and Calico Printer.
Educational Times.
Engineering Magazine (New York).
Furniture and Decoration.
Giornale del Genio Civile.
Hardware Trade Journal.

Inland Architect (Chicago).
Irish Textile Journal.
Knowledge.
Leather Trades' Circular.
Machinery Market.
Marine Engineer.
Mariner.
Moniteur Scientifique.
Music.
Musical Times.
Nautical Magazine.
Oestereichische Monatsschrift für den Orient.
Oils, Colours, and Drysalteries.
Painting and Decorating.
Paper Makers' Monthly Trade Journal.
Photogram.
Plumber and Decorator.
Pottery Gazette.
Propriété Industrielle.
Railway Engineer.
Saddlers, Harness Makers, and Carriage Builders' Gazette.
Sugar Cane.
Symons's Monthly Meteorological Magazine.
Textile Manufacturer.
Textile Recorder.
Ulster Agriculturist.
Watchmaker, Jeweller, and Silversmith.

Two-Monthly.

Coach Builders', Harness Makers', and Saddlers' Art Journal.

NEWSPAPERS.

Bombay Gazette (Overland Summary).
Ceylon Observer (Overland Edition).
Daily Inter Ocean (Chicago).
Empire and South African Empire.
Home and Colonial Mail.
Home News.
London Commercial Record.
London and China Telegraph.
Newcastle Weekly Chronicle.
Nottinghamshire Guardian.
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Times of Ceylon (Weekly Summary).
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